(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2003－11237
（P2003－11237A）
(43)公開日　平成15年１月15日(2003.1.15)

| (51)Int.Cl.⁷ | 識別記号 | ＦＩ | | テーマコード(参考) |
|---|---|---|---|---|
| Ｂ２９Ｃ　67/00 | | Ｂ２９Ｃ　67/00 | | ２Ｈ０９７ |
| Ｇ０３Ｆ　7/20 | ５０１ | Ｇ０３Ｆ　7/20 | ５０１ | ４Ｆ２１３ |
| Ｇ０５Ｂ　19/4097 | | Ｇ０５Ｂ　19/4097 | Ｂ | ５Ｈ２６９ |

審査請求　未請求　請求項の数11　ＯＬ　（全 16 頁）

(21)出願番号　特願2001－201961(P2001－201961)

(22)出願日　平成13年７月３日(2001.7.3)

(71)出願人　000001085
株式会社クラレ
岡山県倉敷市酒津1621番地
(72)発明者　日野　憲一
大阪府大阪市北区梅田１丁目12番39号　株式会社クラレ内
(72)発明者　石浦　一成
大阪府大阪市北区梅田１丁目12番39号　株式会社クラレ内
(74)代理人　100093377
弁理士　辻　良子

最終頁に続く

(54)【発明の名称】　立体造形物の製造方法

(57)【要約】
【課題】　１つの立体造形物中に、色調、透明度、力学的特性、物理的特性、化学的特性、生化学的特性等の異なる複数部位が複合的に形成されている精密な立体造形物、特に生体模型として適する立体造形物の製法の提供。
【解決手段】　温度変化で可逆的にゾル－ゲル相転移する２種類以上の光硬化性樹脂組成物を用いて光学的立体造形を行うか、流動開始温度が６０～２００℃の範囲にある２種類以上の熱可塑性重合体又は熱可塑性重合体組成物を用いて立体造形を行うか、或いは前２者の方法を組み合わせて立体造形を行う方法。

【特許請求の範囲】

【請求項１】　温度変化により可逆的に且つ急速にゾル－ゲル相転移を引き起こす２種類以上の光硬化性樹脂組成物を用い、三次元データをコンピューターにより平行にスライスしてなるスライス形状データに基づいて、該２種類以上の光硬化性樹脂組成物のうちの１種類または２種類以上を、ゾル状で前記スライス形状データの占める面積以上で平らに１層分供給すると共に直ちに冷却ゲル化させ、該光硬化性樹脂組成物層における光硬化させたくない部位にマスクパターンを施した後、光を照射してマスクパターンが施されていない部位を光硬化させ、次いで光硬化した部位を含む前記樹脂層上に、三次元データをコンピューターにより平行にスライスしてなる次のスライス形状データに基づいて前記した光硬化性樹脂組成物のうちの１種類または２種類以上をゾル状で新たに平らに１層分供給すると共に直ちに冷却ゲル化させ、該光硬化性樹脂組成物層における光硬化させたくない部位にマスクパターンを施した後に光を照射してマスクパターンが施されていない部位を光硬化させて光硬化した部位を含む樹脂層を形成させ、三次元データに相当する立体状光硬化物が形成されるまで前記操作を複数回繰り返し、次いで前記立体状光硬化物から光硬化されなかった光硬化性樹脂組成物を取り除くことを特徴とする立体造形物の製造方法。

【請求項２】　流動開始温度が６０～２５０℃の範囲にある２種類以上の熱可塑性重合体または熱可塑性重合体組成物を用い、三次元データをコンピューターにより平行にスライスしてなるスライス形状データに基づいて、該２種類以上の熱可塑性重合体または熱可塑性重合体組成物のうちの１種類または２種類以上を、個別のＸ－Ｙプロッター装置に設けてなるノズルから流動状態で平らに１層分供給すると共に直ちに冷却固化させ、次いで該冷却固化した層上に、三次元データをコンピューターにより平行にスライスしてなる次のスライス形状データに基づいて前記した熱可塑性重合体または熱可塑性重合体組成物のうちの１種類または２種類以上を流動状態で新たに平らに１層分供給すると共に直ちに冷却固化させ、三次元データに相当する立体状固化物が形成されるまで前記操作を複数回繰り返すことを特徴とする立体造形物の製造方法。

【請求項３】　温度変化により可逆的に且つ急速にゾル－ゲル相転移を引き起こす光硬化性樹脂組成物の１種類以上と、流動開始温度が６０～２５０℃の範囲にある熱可塑性重合体または熱可塑性重合体組成物の１種類以上を用い、三次元データをコンピューターにより平行にスライスしてなるスライス形状データに基づいて、前記した光硬化性樹脂組成物、熱可塑性重合体および熱可塑性重合体組成物のうちの１種類または２種類以上をゾル状または流動状態で前記スライス形状データの占める面積以上で平らに１層分供給すると共に直ちに冷却してゲル化および／または固化させ、該層における光硬化させたくない部位にマスクパターンを施した後、光を照射してマスクパターンが施されていない光硬化性樹脂組成物部位を光硬化させ、次いで光硬化した部位を含む前記層上に、三次元データをコンピューターにより平行にスライスしてなる次のスライス形状データに基づいて前記した光硬化性樹脂組成物と熱可塑性重合体または熱可塑性重合体組成物のうちの１種類または２種類以上をゾル状または流動状態で新たに平らに１層分供給すると共に直ちに冷却してゲル化および／または固化させ、該層における光硬化させたくない部位にマスクパターンを施した後に光を照射してマスクパターンが施されていない光硬化性樹脂組成物部位を光硬化させて光硬化した部位を含む層を形成させ、三次元データに相当する立体状物が形成されるまで前記操作を複数回繰り返し、次いで立体状物から光硬化されなかった光硬化性樹脂組成物を取り除くことを特徴とする立体造形物の製造方法。

【請求項４】　マスクパターンを、ゲル化および／または固化した層上に光不透過性インクをジェット噴射することによって施す請求項１または３に記載の製造方法。

【請求項５】　２種類以上の光硬化性樹脂組成物、２種類以上の熱可塑性重合体または熱可塑性重合体組成物、或いは光硬化性樹脂組成物の１種類以上と熱可塑性重合体または熱可塑性重合体組成物の１種類以上として、製造される立体造形物中に組成、色調、透明度、力学的特性、物理的特性および化学的特性のうちの少なくとも１つにおいて互いに異なる部位を形成するものを用いる請求項１～４のいずれか１項に記載の製造方法。

【請求項６】　前記スライス形状データが、生体の一部または全身より得られた断層撮影データであり、立体造形物が生体模型である請求項１～５のいずれか１項に記載の製造方法。

【請求項７】　請求項１～６のいずれか１項に記載の製造方法で得られる立体造形物。

【請求項８】　生体模型である請求項７に記載の立体造形物。

【請求項９】　患部組織の形態を忠実に再現した生体模型である請求項８に記載の立体造形物。

【請求項１０】　生体模型における患部組織に相当する部位が、正常組織とは異なった色調、透明度、力学的特性および／または物理的特性を有する光硬化樹脂または熱可塑性重合体から形成されている請求項９に記載の立体造形物。

【請求項１１】　生体模型における異なる生体組織に相当する部位が、色調、透明度、力学的特性および／または物理的特性の異なる光硬化樹脂または熱可塑性重合体から形成されている請求項８に記載の立体造形物。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、２種類以上の光硬

化性樹脂組成物および／または熱可塑性重合体（熱可塑性重合体組成物）を用いて、各樹脂組成物からなる部位および／または各熱可塑性重合体からなる部位が１つの立体造形物中で立体的に複合化されている立体造形物を迅速に且つ精密に製造する方法、並びにそれにより得られる立体造形物に関する。本発明の方法は生体模型の製造法として特に有用であり、本発明により得られる立体造形物、特に生体模型は、生体の状態を正確に再現していることから、例えば医学生の教育や実習、医師による術前の確認または練習のための医療シミュレーション用などの用途に有効に使用することができる。

【０００２】

【従来の技術】従来、医学生の教育や実習、医師による術前の確認や練習用などのような医療用シミュレーションに使用される生体模型は、その大半は無機的なマネキン様のものであった。また、近年、軟質エラストマーを用いて作製されていて、場合によっては気管、肺または心臓に相当する内部構造、模擬血液を含むチューブなどを有する軟質の人形が、救命蘇生の訓練、静脈注射の練習などに使用されるようになっている。しかしながら、それらは、いずれも代表的な解剖学のデータをもとにして作られた画一的なマネキンの域を出るものではなく、個々の患者に特有の病巣状況や生体形態を忠実に再現したものではない。そのため、医療処置手順の練習には役に立つが、医師による術前の確認または練習用などの医療用シミュレーション用には十分に役立つものではなかった。

【０００３】また、近年、通常の切開手術に比較して患者に与えるダメージが少ないことから、内視鏡を用いる手術法が進歩し、脚光を浴びている。内視鏡手術に当たっては、患部を撮影してその映像を見ながら手術を行うことも行われているが、切開手術とは異なり、患部を直接目視しながら手術を行うものではないため、高い習熟度が要求される。そこで、内視鏡手術を実際に行う前に何度かシミュレーションシしておきたいという要望が強いが、個々の患者の患部状況を忠実に再現した生体模型がないことから、実現されていないのが実情である。

【０００４】一方、国際公開ＷＯ　０１／１０６３２号公報には、温度などの物理変化により可逆的かつ急速にゾルーゲル相転移を引き起こす１種類の光硬化性樹脂組成物を１層ずつ層状に施し、光硬化させたくない部位にマスクパターンを描画した後に光を照射して硬化させる操作を繰り返すことによって造形物を形成する光造形方法が開示されている。この方法による場合は、サポートを配置することなく光造形物を迅速に製造することができるが、１種類の光硬化性樹脂組成物を用いて光造形を行っているために、例えば、患部に相当する部位と正常組織に相当する部位とが１つの立体造形物中に区別可能に形成され複合化されていて医療分野でのシミュレーションなどに有効に用い得る高機能の生体模型などを製造することができない。しかも、この公報には、その光学的立体造形法を歯車などの一般工業用品の作製に適用することが記載されているだけであり、生体模型の作製に応用することすらも記載されていない。

【０００５】また、上記国際公開公報に記載された方法に限らず、光硬化性樹脂組成物を用いて立体造形物を製造する光学的立体造形法は従来からも種々知られているが、従来の光学的立体造形法においても１種類の光硬化性樹脂組成物のみを用いて造形が行われているため、互いに区別可能な部位が１つの立体造形物中に複合的に形成されていることが強く求められている生体模型の製造には十分に適用できない。さらに、生体模型に限らず、工業部品モデルなどとして用いられる光造形物においても、１つの造形物中に色調、力学的特性、物理的特性などが異なる複数の部位が複合的に形成されている立体造形物が必要な場合があるが、１種類の光硬化性樹脂組成物のみを使用して光学的立体造形を行っている従来の光学的立体造形法ではそのような造形物を製造することは困難であった。

【０００６】

【発明が解決しようとする課題】本発明の目的は、１つの立体造形物中に、例えば、色調、透明度、力学的特性、物理的特性、化学的特性などが異なる複数の部位が複合的に形成されている立体造形物を、迅速に且つ高い造形精度で製造することのできる立体造形法を提供することである。特に、本発明は、医学生の教育実習、訓練、医療用シミュレーションなどに用いる生体模型として、より実物の生体に近い状態の生体模型を生産性よく製造することのできる立体造形法を提供することを重要な目的とするものである。そして、本発明の目的は、色調、透明度、力学的特性、物理的特性、化学的特性などが異なる複数の部位が１つの立体造形物中に精密に且つ複合的に形成されている生体模型やその他の立体造形物を提供することである。

【０００７】

【課題を解決するための手段】本発明者らは、上記の課題を解決するために鋭意検討した結果、温度変化により可逆的に且つ急速にゾルーゲル相転移を引き起こす光硬化性樹脂組成物を２種類以上用いて特定の光学的立体造形法を行うか、流動開始温度が６０～２５０℃の範囲にある２種類以上の熱可塑性重合体または熱可塑性重合体組成物を用いて特定の方法で立体造形を行うか、或いは温度変化により可逆的に且つ急速にゾルーゲル相転移を引き起こす光硬化性樹脂組成物の１種類以上と流動開始温度が６０～２５０℃の範囲内にある熱可塑性重合体または熱可塑性重合体組成物の１種類以上を用いて特定の方法で立体造形を行うと、色調、透明度、力学的特性、物理的特性、化学的特性などの異なる複数の部位が１つの造形物中に複合的に形成されている立体造形物を、迅速に且つ高い造形精度で製造できること、そしてこれら

の立体造形法は生体模型の製造方法として特に有効であることを見出して本発明を完成した。

【０００８】すなわち、本発明は、（１）　温度変化により可逆的に且つ急速にゾルーゲル相転移を引き起こす２種類以上の光硬化性樹脂組成物を用い、三次元データをコンピューターにより平行にスライスしてなるスライス形状データに基づいて、該２種類以上の光硬化性樹脂組成物のうちの１種類または２種類以上を、ゾル状で前記スライス形状データの占める面積以上で平らに１層分供給すると共に直ちに冷却ゲル化させ、該光硬化性樹脂組成物層における光硬化させたくない部位にマスクパターンを施した後、光を照射してマスクパターンが施されていない部位を光硬化させ、次いで光硬化した部位を含む前記樹脂層上に、三次元データをコンピューターにより平行にスライスしてなる次のスライス形状データに基づいて前記した光硬化性樹脂組成物のうちの１種類または２種類以上をゾル状で新たに平らに１層分供給すると共に直ちに冷却ゲル化させ、該光硬化性樹脂組成物層における光硬化させたくない部位にマスクパターンを施した後に光を照射してマスクパターンが施されていない部位を光硬化させて光硬化した部位を含む樹脂層を形成させ、三次元データに相当する立体状光硬化物が形成されるまで前記操作を複数回繰り返し、次いで立体状光硬化物から光硬化されなかった光硬化性樹脂組成物を取り除くことを特徴とする立体造形物の製造方法（以下「本発明第１方法」ということがある）である。

【０００９】そして、本発明は、（２）　流動開始温度が６０～２５０℃の範囲にある２種類以上の熱可塑性重合体または熱可塑性重合体組成物を用い、三次元データをコンピューターにより平行にスライスしてなるスライス形状データに基づいて、該２種類以上の熱可塑性重合体または熱可塑性重合体組成物のうちの１種類または２種類以上を、個別のＸ－Ｙプロッター装置に設けてなるノズルから流動状態で平らに１層分供給すると共に直ちに冷却固化させ、次いで該冷却固化した層上に、三次元データをコンピューターにより平行にスライスしてなる次のスライス形状データに基づいて前記した熱可塑性重合体または熱可塑性重合体組成物のうちの１種類または２種類以上を流動状態で新たに平らに１層分供給すると共に直ちに冷却固化させ、三次元データに相当する立体状固化物が形成されるまで前記操作を複数回繰り返すことを特徴とする立体造形物の製造方法（以下「本発明第２方法」ということがある）である。

【００１０】さらに、本発明は、（３）　温度変化により可逆的に且つ急速にゾルーゲル相転移を引き起こす光硬化性樹脂組成物の１種類以上と、流動開始温度が６０～２５０℃の範囲にある熱可塑性重合体または熱可塑性重合体組成物の１種類以上を用い、三次元データをコンピューターにより平行にスライスしてなるスライス形状データに基づいて、前記した光硬化性樹脂組成物、熱可塑性重合体および熱可塑性重合体組成物のうちの１種類または２種類以上をゾル状または流動状態で前記スライス形状データの占める面積以上で平らに１層分供給すると共に直ちに冷却してゲル化および／または固化させ、該層における光硬化させたくない部位にマスクパターンを施した後、光を照射してマスクパターンが施されていない光硬化性樹脂組成物部位を光硬化させ、次いで光硬化した部位を含む前記層上に、三次元データをコンピューターにより平行にスライスしてなる次のスライス形状データに基づいて前記した光硬化性樹脂組成物と熱可塑性重合体または熱可塑性重合体組成物のうちの１種類または２種類以上をゾル状または流動状態で新たに平らに１層分供給すると共に直ちに冷却してゲル化および／または固化させ、該層における光硬化させたくない部位にマスクパターンを施した後に光を照射してマスクパターンが施されていない光硬化性樹脂組成物部位を光硬化させて光硬化した部位を含む層を形成させ、三次元データに相当する立体状物が形成されるまで前記操作を複数回繰り返し、次いで立体状物から光硬化されなかった光硬化性樹脂組成物を取り除くことを特徴とする立体造形物の製造方法（以下「本発明第３方法」ということがある）である。

【００１１】そして、本発明は、（４）　マスクパターンを、ゲル化および／または固化した層上に光不透過性インクをジェット噴射することによって施す前記（１）または（３）の製造方法；（５）　２種類以上の光硬化性樹脂組成物、２種類以上の熱可塑性重合体または熱可塑性重合体組成物、或いは光硬化性樹脂組成物の１種類以上と熱可塑性重合体または熱可塑性重合体組成物の１種類以上として、製造される立体造形物中に組成、色調、透明度、力学的特性、物理的特性および化学的特性のうちの少なくとも１つにおいて互いに異なる部位を形成するものを用いる前記した（１）～（４）のいずれかの製造方法；および、（６）　前記スライス形状データが、生体の一部または全身より得られた断層撮影データであり、立体造形物が生体模型である前記（１）～（５）のいずれかの製造方法；を包含する。

【００１２】さらに、本発明は、（７）　前記（１）～（６）のいずれかの製造方法で得られる立体造形物；（８）　生体模型である前記（７）の立体造形物；（９）　患部組織の形態を忠実に再現した生体模型である前記（８）の立体造形物；（１０）　生体模型における患部組織に相当する部位が、正常組織とは異なった色調、透明度、力学的特性および／または物理的特性を有する光硬化樹脂または熱可塑性重合体から形成されている前記（９）の立体造形物；および、（１１）　生体模型における異なる生体組織に相当する部位が、色調、透明度、力学的特性および／または物理的特性の異なる光硬化樹脂または熱可塑性重合体から形成されている前記（８）の立体造形物；である。

【００１３】
【発明の実施の形態】以下に本発明について詳細に説明する。まず、本発明第１方法、本発明第２方法および本発明第３方法（以下これらを総称する場合は「本発明方法」ということがある）を行う際の基本データである「三次元データをコンピューターにより平行にスライスしてなるスライス形状データ」とは、三次元ＣＡＤデータ、特定の物品を三次元測定機で測定して得られる三次元データ、生体の一部または全部を断層撮影装置（ＣＴスキャナーなど）で撮影して得られる三次元データなどを、立体造形を行うためにコンピューターによって平行に薄くスライスして得られる個々のスライス形状データ（スライス断面データ）をいう。本発明方法によって生体模型を製造する場合は、該スライス形状データとして、生体の一部または全部を断層撮影装置（ＣＴスキャナーなど）で撮影して得られる三次元データをコンピューターによって平行に薄くスライスして得られる個々のスライス形状データが１層ごとの光硬化樹脂層または固化重合体層を形成するためのデータとして採用される。より具体的には、例えば、患部などのＸ線ＣＴスキャン画像データをコンピューター内でＳＴＬフォーマット（三次元自由曲面を三角パッチの集合体で近似する方式）に変換する。患部ＳＴＬデータを元に造形装置内での配置や積層方向（モデルの置き方）などを決定し、使用する樹脂や重合体の種類などによってサポートが必要な場合には別途コンピューター内でデータを作製し、患部モデル三次元データに加える。更に、場合によりサポート付きの患部モデル三次元データをコンピューター内でスライスして各層の断面データ（等高線データ）を求め、これを立体造形を行う際のスライス形状データとする。

【００１４】（Ｉ）本発明第１方法：最初に本発明第１方法について説明する。本発明第１方法は、温度変化により可逆的に且つ急速にゾルーゲル相転移を引き起こす光硬化性樹脂組成物を用い、光硬化させたくない部位にマスクパターンを施してから光照射を行って立体造形物を製造する方法であり、この点で前記した国際公開ＷＯ　０１／１０６３２号公報に開示されている方法と共通している。しかしながら、本発明第１方法は２種類以上の光硬化性樹脂組成物を用いることを必須にしているのに対して、国際公開ＷＯ　０１／１０６３２号公報に記載されている方法では１種類の光硬化性樹脂組成物のみを用いていており、この点で大きく相違する。２種類以上の光硬化性樹脂組成物を用いる本発明第１方法による場合は、使用する２種類以上の光硬化性樹脂組成物の組み合わせ方によって、例えば、色調、透明度、力学的特性、物理的特性および／または化学的特性の異なる部位が１つの造形物中に複合的に形成された精密な立体造形物が形成できるが、国際公開ＷＯ　０１／１０６３２号公報に記載の方法では、上記のようにそのような異なる部位が１つの立体造形物中に複合的に形成されている立体造形物は形成されない。

【００１５】本発明第１方法では、まず、温度変化により可逆的に且つ急速にゾルーゲル相転移を引き起こす２種類以上の光硬化性樹脂組成物を用い、三次元データをコンピューターにより平行にスライスしてなるスライス形状データに基づいて、該２種類以上の光硬化性樹脂組成物のうちの１種類または２種類以上を、ゾル状を呈する温度に加熱してゾル状にして（流動性にし）、前記スライス形状データの占める面積以上で、造形ステージ（造形テーブル）上に平らに１層分供給する。この際に前記１層分の形成に当たって、１種類の光硬化性樹脂組成物のみが供給されるか、または２種類以上の光硬化性樹脂組成物が供給されるかは、該層を形成する際のベースとなるスライス形状データの内容による。スライス形状データが、その外側の輪郭を除いて全体的に１つの均質部分よりなるデータ内容である場合（例えば、図２におけるｎ＝１に相当するスライス形状データの場合）には、１種類の光硬化性樹脂組成物のみが供給されて該１層分の層形成がなされる。また、スライス形状データが、互いに不均質な複数部分を有するデータ内容である場合（例えば、図２におけるｎ＝ｐ＋１に相当するスライス形状データの場合）には、該不均質な複数部分に相当する数の複数種類の光硬化性樹脂組成物が予め混合されることなくそれぞれ別々に供給され、且つスライス形状データの内容に応じて１つの層内のそれぞれの位置に配置された（分布された）１つの層が形成される。１種類または２種類以上の光硬化性樹脂組成物を供給して形成された前記１つの層は直ちにそのゲル化温度以下に冷却されてゲル化される。特に該１つの層が２種類以上の光硬化性樹脂組成物から形成されている場合は、該１つの層内で複数の光硬化性樹脂組成物間の混合が生じないようにゲル化を速やかに行う必要がある。

【００１６】次いで、光硬化性樹脂組成物よりなる前記１つの層において、光硬化させたくない部位にマスクパターンを施した後、光を照射してマスクパターンが施されていない部位を光硬化させる。続いて、光硬化した部位を含む前記樹脂層上に、三次元データをコンピューターにより平行にスライスしてなる次のスライス形状データに基づいて前記した光硬化性樹脂組成物のうちの１種類または２種類以上をゾル状で新たに平らに１層分供給すると共に直ちに冷却ゲル化させ、該光硬化性樹脂組成物層における光硬化させたくない部位にマスクパターンを施した後に光を照射してマスクパターンが施されていない部位を光硬化させて光硬化した部位を含む樹脂層を形成させる。そして、三次元データに相当する立体状光硬化物が形成されるまで前記した操作を複数回繰り返す。最後に、前記で生成した立体状光硬化物から、光硬化されなかった光硬化性樹脂組成物を取り除いて、目的とする立体造形物を得る。

【００１７】本発明第１方法で用いる温度変化により可逆的に且つ急速にゾルーゲル相転移を引き起こす光硬化性樹脂組成物としては、６０～２００℃、特に８０～１５０℃の温度範囲内で可逆的に且つ急速にゾルからゲルにまたはゲルからゾルに相転移を引き起こす光硬化性樹脂組成物が、光硬化性樹脂組成物よりなる各層の形成容易性、該層を形成した後のゲル化の容易性などの点から好ましく用いられる。本発明第１方法で用いる光硬化性樹脂組成物は、一般に、光硬化性オリゴマーおよび／またはモノマーからなる光硬化性成分、光硬化性樹脂組成物を温度変化により可逆的にゾルーゲル相転移させるための流動性調節用成分、および光重合開始剤を含有し、さらに必要に応じてその他の樹脂用添加物、例えば、チクソトロピー性発現剤、充填剤、可塑剤、安定剤、着色剤、難燃剤、酸化防止剤、帯電防止剤などを含むものである。

【００１８】本発明第１方法で用いられる光硬化性樹脂組成物を構成する上記した光硬化性成分としては、光硬化性樹脂組成物において従来から用いられている光硬化性オリゴマーおよび／またはモノマーのいずれもが使用でき、例えば、単官能または多官能のアルキル（メタ）アクリレート系、エポキシ（メタ）アクリレート系、ポリエステル（メタ）アクリレート系、ポリエーテル（メタ）アクリレート系、ウレタン（メタ）アクリレート系などの（メタ）アクリレート系の光硬化性モノマーや光硬化性オリゴマー；ビスフェノールＡ系エポキシ化合物、ノボラック系エポキシ化合物、脂環式エポキシ化合物、ポリフェノール系エポキシ化合物、ポリグリシジルアミン系、アルコール系エポキシ化合物、エステル系エポキシ化合物などの従来公知のエポキシ系光カチオン硬化性樹脂成分を挙げることができ、それらの１種または２種以上を用いることができる。

【００１９】光硬化性樹脂組成物を温度変化により可逆的にゾルーゲル相転移させるための流動性調節用成分としては、重合体が好ましく用いられる。光硬化性オリゴマーおよび／またはモノマーよりなる光硬化性成分は、所定の温度以下になると流動性調節用成分である重合体を溶解せずに膨潤した状態となって光硬化性樹脂組成物全体がゲル状を呈すようになり、一方光硬化性樹脂組成物の温度が所定温度以下になると光硬化性成分が重合体を溶解するかおよび／または重合体が溶融して光硬化性樹脂組成物全体が流動性（ゾル状）を呈するようになり、そのような機構によって光硬化性樹脂組成物が温度変化により可逆的にゾルーゲル相転移を引き起こす。

【００２０】流動性調節用成分として用いられる重合体としては、例えば、前記した光硬化性モノマーの単独重合体や共重合体、ポリブタジエン、ポリイソプレン、ポリクロロプレン、ポリ塩化ビニル、ポリスチレン、ポリカプロラクトン、ニトリルゴム、ナイロン、ポリウレタン、セルローストリブチレート、セルローストリニトレート、ポリエチレンオキシド、ポリオキシメチレン、ポリアクリロニトリル、コラーゲン、ポリビニルアルコール、ポリ塩化ビニリデン、ポリビニルブチラール、エポキシ樹脂、ポリ－４－メチルペンテン、ポリエステル、フェノール樹脂、尿素樹脂、メラニン樹脂、ジアリルフタレート樹脂、シリコーン樹脂などの汎用の重合体、これらの重合体を構成する繰り返し単位を含む共重合体、前記重合体または共重合体の各種の架橋物、それらの２種以上のブレンド物、シンジオタクチックポリアルキルメタクリレートとアイソタクチックポリアルキルメタクリレートの混合物などを挙げることができる。そのうちでも、本発明では、流動性調節用成分として、シンジオタクチックポリアルキルメタクリレートとアイソタクチックポリアルキルメタクリレートの混合物、特にシンジオタクチックポリメチルメタクリレートとアイソタクチックポリメチルメタクリレートの混合物を含むものが好ましく用いられる。

【００２１】ここで、前記したシンジオタクチックポリメチルメタクリレートとしては、重合体中にシンジオタクチックな３連子（連続する３個のモノマー単位）の割合が６０～９０％程度のものが好ましく用いられ、６５～８０％程度のものがより好ましく用いられる。また、前記したアイソタクチックポリメチルメタクリレートとしては、重合体中にアイソタクチックな３連子の割合が８０～９５％程度のものが好もしく用いられ、８５～９５％程度のものがより好ましく用いられる。シンジオタクチックポリメチルメタクリレート：アイソタクチックポリメチルメタクリレートの質量比は、これらの重合体の重合度やタクチシティーなどにより異なるが、光硬化性樹脂組成物の取扱性などの点から、通常１：１０～１０：１であるのが好ましく、２：１であるのがより好ましい。光硬化性樹脂組成物中におけるシンジオタクチックポリメチルメタクリレートおよびアイソタクチックポリメチルメタクリレートの含有量は、光硬化性樹脂組成物全体の質量に対して、それぞれ１質量％以上であることが好ましく、２～３０質量％であることがより好ましい。

【００２２】特に、医療用シミュレーションなどの目的で用いられる生体模型では、骨を模した硬い立体造形物だけではなく、血管や内臓組織などを模した軟らかい立体造形物が求められることが多い。そのため、本発明第１方法によって柔らかい生体模型を製造する場合は、光硬化性樹脂組成物中の流動性調節成分として、例えばブタジエン、イソプレン、クロロプレンなどの共役ジエンの重合体または共重合体よりなるエラストマー、スチレン系重合体ブロック－（水添）ジエン系重合体ブロックを有するブロック共重合体などに代表される熱可塑性エラストマーを用い、それらのエラストマーに、前記した光重合性モノマーまたはオリゴマーのうちで比較的分子鎖が長くて可塑剤的な性質を示し得るものを光硬化性成

分として組み合わせて光硬化性樹脂組成物を調製し、それを用いて立体造形を行うとよい。そのような光硬化性樹脂組成物では、温度によって光重合性モノマーおよび／またはオリゴマーによるエラストマー粒子の膨潤度合が変化し、それによって光硬化性樹脂組成物が温度変化により可逆的にゾルーゲル相転移を生ずるようになる。

【００２３】本発明第１方法で使用する光硬化性樹脂組成物で使用する光重合開始剤は、紫外線および／または可視光線を使用する光重合技術において光重合開始剤として用いられる従来既知の光重合開始剤であればいずれでもよく、具体例としては、従来公知のベンゾフェノン系化合物、ベンゾインアルキルエーテル系化合物、チオキサントン系化合物、アントラキノン系化合物、ナフトキノン系化合物、ケタール系化合物、α－ジケトン系化合物、アシルホスフィンオキサイド系化合物などを挙げることができ、これらの１種または２種以上を用いることができる。

【００２４】本発明第１方法で用いる光硬化性樹脂組成物は、本発明の趣旨を損なわない範囲内で、必要に応じて、チクソトロピー性を発現する微細な充填剤、例えば、ヒュームドシリカ、コロイダルシリカ等の球形のもの、シリカゲルなどの球状粉体が凝集したもの、粘土鉱物のような板状のもの、ウィスカーまたは有機繊維のような針状あるいは繊維状のものなどを含有していてもよい。さらに、本発明第１方法で用いる光硬化性樹脂組成物は、本発明の趣旨を損なわない範囲内で、その他の充填剤、可塑剤、安定剤、着色剤、難燃剤、酸化防止剤あるいは帯電防止剤を必要に応じて適宜含有していてもよい。

【００２５】本発明第１方法では、２種類以上の光硬化性樹脂組成物が用いられる。本発明第１方法で用いられる２種類以上の光硬化性樹脂組成物としては、最終的に製造される立体造形物の種類、用途、立体造形物に要求される特性などに基づいて、立体造形物中に、例えば、組成；色調；透明度；例えば強度、伸長率、弾性率、硬度、柔軟性、圧縮特性、耐熱性、気体透過性、引張特性、耐寒性などの力学的特性や物理的特性および耐薬品性、耐候性、耐加水分解性、耐水性などの化学的特性のうちの少なくとも１つにおいて互いに異なる部位を形成するものを用いるとよい。例えば、色調や透明度が互いに異なる部位を有する立体造形物を製造する場合は、着色剤を含有する光硬化性樹脂組成物と着色剤を含有しない光硬化性樹脂組成物との組み合わせ、充填剤を含有する光硬化性樹脂組成物と透明な光硬化物を形成する光硬化性樹脂組成物との組み合わせなどを用いればよい。また、硬度が互いに異なる部位を有する立体造形物を製造する場合は、例えば、軟質の光硬化物を形成する光硬化性樹脂組成物と硬質の光硬化物を形成する光硬化性樹脂組成物の組み合わせなどを用いればよい。本発明第１方法によって生体模型を製造する場合に、２種類以上の光硬化性樹脂組成物の組み合わせを選択することによって、例えば、ガン組織などの患部に相当する部位と正常組織に相当する部位とで、また筋肉に相当する部位と血管に相当する部位とで、さらには筋肉に相当する部位と骨に相当する部位とで、互いに色調、透明度、硬さなどにおいて異なるようにして光硬化物を形成すると、手術前のシミュレーション、医学生の教育や訓練用などに極めて有用な、精密な生体模型を簡単に且つ迅速に製造することができる。

【００２６】本発明第１方法において、造形ステージ（造形テーブル）上に第１の層を形成する際に、また既に光硬化した樹脂層上に更に１つの層を形成するに当たって、造形ステージ上または光硬化した樹脂層上に光硬化性樹脂組成物を供給する方法は特に制限されず、例えば、２種類以上の光硬化性樹脂組成物の各々を個別に収容しゾル状で排出させ得る２つ以上の容器（タンク）、光硬化性樹脂組成物を容器から吐出させるための加圧手段、吐出量や供給量の制御手段、さらに好ましくはＸ－Ｙ方向の位置検出手段を有するアプリケーター（Ｘ－Ｙプロッター装置）を備えた供給装置により、２種類以上の光硬化性樹脂組成物の１種類または２種類以上を、各層を形成するための各スライス形状データに応じて造形ステージの上または光硬化した樹脂層の上の所定の位置に一定量ずつ押し出す方法などが挙げられる。また、光硬化した樹脂層の積層数が多くなり、光硬化物の厚みが厚くなるに従って、重合収縮に基づく歪の影響が光硬化樹脂層の歪み（平面性の不良）という形で顕れることがある。この場合に、そのような現象を回避するために、光硬化した樹脂層の平面性を検出するレベル検出手段を設け、アプリケーターからの吐出量を調節・制御するプログラムを組んでもよい。また、別の方法として、供給した光硬化性樹脂組成物をリコーターにより平らにならしてもよい。

【００２７】また、本発明第１方法において、光硬化性樹脂組成物よりなる層上にマスクパターンを施す方法としては、任意の方法を採用することができ、例えば光不透過性インクを用いてインクジェット手段を使用して光硬化性樹脂組成物よりなる層の上にマスクパターンを印刷する方法、マスクパターンを形成した透明フィルム（ＰＥＴフィルムなど）を光硬化性樹脂組成物層と光源との間に配置する方法などを挙げることができる。そのうちでも、光不透過性インクを用いてインクジェット手段でマスクパターンを印刷する方法が好ましく採用される。すなわち、本発明第１方法で用いる光硬化性樹脂組成物は、温度変化により可逆的に且つ急速にゾルーゲル相転移を引き起こす樹脂組成物であって、該光硬化性樹脂組成物を用いて形成された層は、マスクパターンを施す際にはゲル状（固形状）を呈しているので、該層の上に光透過性インクを噴霧してマスクパターンを直接印刷してもマスクパターンが崩れることがなく、この方法に

よる場合は所望のマスクパターンを極めて短時間で良好に形成することができる。その際に、マスクパターンの形成に用いられる光不透過性インクとしては、例えば、カーボンブラック、酸化鉄、酸化チタン、その他の微細で不透明な粉末を界面活性剤を含む水や溶剤中に増粘剤とともに分散させたインク、ベンゾフェノン系、ベンゾトリアゾール系、サリチル酸系、ヒンダードアミン系などの紫外線吸収剤の１種または２種以上を増粘剤、溶剤等に溶かしたインクなどを挙げることができる。

【００２８】本発明第１方法において、光硬化性樹脂組成物よりなる層を硬化させるための光照射装置としては、水銀灯、キセノンランプ、メタルハライドランプ、ハロゲンランプなどの従来公知のランプ手段、光学系の制御および照射時間などの制御を行うための制御手段、ランプ手段や制御手段の冷却手段、光の外部への漏出を防ぐ筐体などからなるものが好ましく使用される。造形ステージ上に施されている（載置されている）光硬化性樹脂組成物の上面全体に均一に光を照射し得るように、複数のランプを備えていてもよいし、また造形ステージが回転するターンテーブルであってもよい。但し、ターンテーブル方式を採る場合には、しっかりしたテーブルの位置決め手段を設ける必要がある。

【００２９】また、本発明第１方法において、必要な全ての光硬化工程を終えて生成した立体状光硬化物から、光硬化されなかった光硬化性樹脂組成物を取り除いて、立体造形物を得るに当たっては、光硬化物が変質しない溶媒を用いて未硬化の光硬化性樹脂組成物を洗い流す方法、前記方法を超音波を当てながら行なう方法、溶媒を用いずに加熱により未硬化の光硬化性樹脂組成物部分をゾル状にして（流動化して）光硬化物から分離させる方法などのいずれの方法を採用してもよい。未硬化の光硬化性樹脂組成物部分を光硬化物から分離した後に得られる立体造形物にベタツキが残っていて、手などを汚す恐れがある場合は、立体造形物に再度光を照射して硬化を完結させてもよい。

【００３０】本発明第１方法によって立体造形物を製造する場合は、立体造形物がオーバーハング形状のものであっても、サポートなどを使用することなく、目的とする立体造形物を良好な寸法精度で簡単に且つ生産性良く製造することができる。かかる点から、本発明第１方法により、生体の一部または全身の形態を忠実に再現した精密な生体模型を製造することができる。本発明第１方法によって、例えば、ガンに侵された肝臓組織と正常な肝臓組織とを色調的に区別した生体模型を製造することができる。限定されるものではないが、そのような生体模型を製造するために、生体の肝臓部分より得られた各断層撮影データ（肝臓の各スライス形状データ）に応じて、例えば色調、透明度または組成の異なる２種類以上の光硬化性樹脂組成物を、個別のノズルを有する個々のＸ－Ｙプロッター装置を用いて生体模型製造用ステージ上の所定の位置に、ガンに侵された肝臓組織と正常な肝臓組織のそれぞれに対応させて別々に供給し、不要部あるいは輪郭線等の硬化させたくない部位に光不透過性インクを噴射するインクジェット手段などを用いてマスクパターンを施し、該光硬化性樹脂組成物およびマスクパターンの上から光照射を行って肝臓の各スライス形状データに対応する硬化樹脂層を形成させ、前記操作を肝臓全体に相当する光造形物が形成されるまで繰り返し、最後に硬化しなかった光硬化性樹脂組成物部分を光硬化物部分から取り除く方法などが採用される。それによって、ガンに侵された肝臓組織に相当する部位と、正常な肝臓組織に相当する部位とで、色調、透明度またはその他の物性が異なる精密な肝臓模型を製造することができる。

【００３１】また、本発明第１方法によって、マスクパターンを生体組織の外縁相当部位の形成のためにのみ用いずに、異なる生体組織間の輪郭線（境界部）に相当する部位に施すと、その部位では光が遮蔽された光硬化性樹脂組成物が硬化しないことから、異なる生体組織に相当する部位の境界に隙間を有する生体模型を形成することができる。また、生体の柔組織に相当する部位を軟質の光硬化樹脂から形成し、生体の硬質組織に相当する部位を硬質の光硬化樹脂から形成し、前記したマスキング方法によって両組織間に隙間を形成すると、生体により近似したリアルな生体模型を形成することもできる。

【００３２】（II）本発明第２方法：次に、本発明第２方法について説明する。本発明第２方法は、流動開始温度が６０～２５０℃、好ましくは８０～１８０℃の範囲にある２種類以上の熱可塑性重合体または熱可塑性重合体組成物を用い、三次元データをコンピューターにより平行にスライスしてなるスライス形状データに基づいて、該２種類以上の熱可塑性重合体または熱可塑性重合体組成物のうちの１種類または２種類以上を、それぞれの熱可塑性重合体または熱可塑性重合体組成物ごとに設けられている個別のＸ－Ｙプロッター装置に取り付けてなるノズルから、それぞれ流動状態（溶融状態）で造形ステージ（造形テーブル）上に平らに１層分、例えば面状で供給すると共に直ちに冷却固化させ、次いでその冷却固化した層上に、三次元データをコンピューターにより平行にスライスしてなる次のスライス形状データに基づいて前記した熱可塑性重合体または熱可塑性重合体組成物のうちの１種類または２種類以上をそれぞれの熱可塑性重合体または熱可塑性重合体組成物ごとに設けられている前記した個別のＸ－Ｙプロッター装置に取り付けてなるノズルからそれぞれ流動状態（溶融状態）で新たに平らに１層分供給すると共に直ちに冷却固化させ、三次元データに相当する立体状固化物が形成されるまで前記操作を複数回繰り返して立体造形物を製造する方法である。

【００３３】本発明第２方法において、前記１層分の重

合体層を形成するに当たって、該１層分の重合体層を形成するために熱可塑性重合体または熱可塑性重合体組成物のうちの１種類のみが供給されるかまたは２種類以上が供給されるかは、該層を形成する際のベースとなるスライス形状データの内容による。スライス形状データが、全体的に１つの均質部分よりなるデータ内容である場合（例えば、図６におけるｎ＝ｐ＋１に相当するスライス形状データの場合）には、１種類の熱可塑性重合体または熱可塑性重合体組成物のみが供給されて該１つの層が形成される。また、スライス形状データが、互いに不均質な複数部分を有するデータ内容である場合（例えば、図６におけるｎ＝ｐ＋２に相当するスライス形状データの場合）には、該不均質な複数部分に相当する数の複数種類の熱可塑性重合体または熱可塑性重合体組成物が個別のＸ－Ｙプロッター装置に取り付けてなるそれぞれのノズルから別々に供給されてスライス形状データの内容に応じて１つの層内のそれぞれの位置に配置されて１つの層が形成される。１種類または２種類以上の熱可塑性重合体または熱可塑性重合体組成物を供給して形成された前記１つの層は直ちにその固化温度以下に冷却されて固化される。特に該１つの層が２種類以上の熱可塑性重合体または熱可塑性重合体組成物から形成されている場合は、１つの層内で複数の熱可塑性重合体または熱可塑性重合体組成物間で混合が生じないように固化を速やかに行う必要がある。

【００３４】本発明第２方法で用いる前記熱可塑性重合体または熱可塑性重合体組成物は、室温では固体状を呈し、その流動開始温度（６０～２５０℃）以上に加熱されると流動する。本発明第２方法では、２種類以上の熱可塑性重合体または熱可塑性重合体組成物として、熱可塑性重合体または熱可塑性重合体組成物の流動開始温度が６０～２５０℃の範囲内にあるものであれば、例えば、種類の異なる２種類以上の熱可塑性重合体の組み合わせ、１つの熱可塑性重合体とそれと同じ熱可塑性重合体に充填剤、着色剤などの添加剤を添加してなる熱可塑性重合体組成物との組み合わせ、同じ熱可塑性重合体をベースとするが組成の異なる２種類以上の熱可塑性重合体組成物の組み合わせ、互いに異なる熱可塑性重合体をベースとする２種類以上の熱可塑性重合体組成物の組み合わせなどのいずれを採用してもよい。本発明第２方法で用い得る熱可塑性重合体または熱可塑性重合体組成物としては、例えば、ワックス、ポリエチレン、ポリプロピレン、エチレン・酢酸ビニル共重合体、エチレン・メチルメタクリレート共重合体、トランスポリイソプレン、ポリカプロラクトン、メチルメタクリレートと他のアルキル（メタ）アクリレートとの共重合体、またはこれらの重合体の１種または２種以上をベースとする熱可塑性重合体組成物が挙げられる。これらのうち、ワックスは立体造形物の製造工程の最終工程で、熱水洗浄や水蒸気洗浄を行うことにより、本体部分から容易に除去できるので、他の熱可塑性重合体および／またはは熱可塑性重合体組成物を用いて本発明第２方法に従って立体造形物を製造する際に、熱可塑性重合体および／または熱可塑性重合体組成物が目的とする立体造形物の輪郭から外方に余分にはみ出して立体造形物の形状精度が失われないようにするための分離手段（補助材料）としても使用することができる。また、本発明第２方法では、立体造形物の形状などに応じて、立体造形物を構成する２種類以上の熱可塑性重合体または熱可塑性重合体組成物と共に、立体造形中にサポートとして機能し立体造形の終了後は立体造形物から取り除かれる熱可塑性重合体または熱可塑性重合体組成物を用いて立体造形を行ってもよい。本発明第２方法で用いる熱可塑性重合体または熱可塑性重合体組成物は、本発明の趣旨を損なわない範囲内で、充填剤、可塑剤、安定剤、着色剤、難燃剤、酸化防止剤、帯電防止剤などの１種または２種以上を必要に応じて含有していてもよい。

【００３５】本発明第２方法では、２種類以上の熱可塑性重合体または熱可塑性重合体組成物として、最終的に製造される立体造形物の種類、用途、立体造形物に要求される特性などに基づいて、立体造形物中に、例えば、組成；色調；透明度；例えば強度、伸長率、弾性率、硬度、柔軟性、圧縮特性、耐熱性、気体透過性、引張特性、耐寒性などの力学的特性や物理的特性および耐薬品性、耐候性、耐加水分解性、耐水性などの化学的特性のうちの少なくとも１つにおいて互いに異なる部位を形成するものが用いられる。例えば、色調や透明度が互いに異なる部位を有する立体造形物を製造する場合は、着色剤を含有する熱可塑性重合体組成物と着色剤を含有しない熱可塑性重合体との組み合わせ、充填剤を含有する熱可塑性重合体組成物と透明な光硬化物を形成する熱可塑性重合体との組み合わせなどを用いればよい。また、硬度が互いに異なる部位を有する立体造形物を製造する場合は、例えば、柔軟性のある熱可塑性重合体または熱可塑性重合体組成物と硬質の熱可塑性重合体または熱可塑性重合体組成物の組み合わせなどを用いればよい。本発明第２方法によって生体模型を製造する場合にも、本発明第１方法の場合と同様に、２種類以上の熱可塑性重合体または熱可塑性重合体組成物の組み合わせを選択することによって、例えば、ガン組織などの患部に相当する部位と正常組織に相当する部位とで、筋肉に相当する部位と血管に相当する部位とで、または筋肉に相当する部位と骨に相当する部位とで、互いに色調、透明度、硬さなどにおいて異なる、手術前のシミュレーション、医学生の教育や訓練用などに役立つ精密な生体模型を簡単に且つ迅速に製造することができる。

【００３６】本発明第２方法において、造形ステージ（造形テーブル）上に熱可塑性重合体または熱可塑性重合体組成物の溶融物を供給して１層分の重合体層を形成する方法としては、例えば、熱可塑性重合体または熱可

塑性重合体組成物を充填してなる容器（タンク）、熱可塑性重合体または熱可塑性重合体組成物を流動開始温度以上に加熱する手段、溶融した熱可塑性重合体または熱可塑性重合体組成物のノズルからの吐出量を定量する手段、ノズルのＸ－Ｙ方向での位置検出手段およびそれらを制御する手段を備えたアプリレーターを使用して、該アプリケーターより熱可塑性重合体または熱可塑性重合体組成物の溶融物をステージ上の所定の位置に一定量ずつ押し出した後、ファン等の手段により発生させたエアーの流れを細い流路に導いて冷却を要する部位に吹き付けて固化する方法が挙げられる。造形テーブル上または既に固化した重合体層上に供給された熱可塑性重合体または熱可塑性重合体組成物の層の表面に突起が生じていて平滑な面となっていない場合は、寸法精度に優れる立体造形物を得るために、熱可塑性重合体または熱可塑性重合体組成物の溶融物の層の表面を平坦化するための手段を設けてもよい。固化した熱可塑性重合体または熱可塑性重合体組成物の層の積層数が多くなり、固化物の厚みが厚くなるに従って、熱可塑性重合体または熱可塑性重合体組成物の収縮に基づく歪の影響が立体造形物における平坦性の欠如という形で顕れることがあるが、必要であれば、固化した重合体層の平坦性を検出するレベル検出手段を設けて、アプリケーターからの吐出量を調節・制御するプログラムを組むこともできる。

【００３７】（III）本発明第３方法：本発明第３方法は、前記した本発明第１方法と本発明第２方法を組み合わせたものであって、温度変化により可逆的に且つ急速にゾルーゲル相転移を引き起こす光硬化性樹脂組成物の１種類以上と、流動開始温度が６０～２５０℃の範囲にある熱可塑性重合体または熱可塑性重合体組成物の１種類以上を用い、三次元データをコンピューターにより平行にスライスしてなるスライス形状データに基づいて、前記した光硬化性樹脂組成物、熱可塑性重合体および熱可塑性重合体組成物のうちの１種類または２種類以上をゾル状または流動状態で、造形ステージ（造形テーブル）上に、前記スライス形状データの占める面積以上で平らに１層分供給すると共に直ちにゲル化および／または固化させ、該層における光硬化させたくない部位にマスクパターンを施した後、光を照射してマスクパターンが施されていない光硬化性樹脂組成物部位を光硬化させ、次いで光硬化した部位を含む前記層上に、三次元データをコンピューターにより平行にスライスしてなる次のスライス形状データに基づいて前記した光硬化性樹脂組成物と熱可塑性重合体または熱可塑性重合体組成物のうちの１種類または２種類以上をゾル状または流動状態で新たに平らに１層分供給すると共に直ちにゲル化および／または固化させ、該層における光硬化させたくない部位にマスクパターンを施した後に光を照射してマスクパターンが施されていない光硬化性樹脂組成物部位を光硬化させて光硬化した部位を含む層を形成させ、三次元データに相当する立体状物が形成されるまで前記操作を複数回繰り返し、次いで立体状物から光硬化されなかった光硬化性樹脂組成物を取り除いて立体造形物を製造する方法である。

【００３８】本発明第３方法では、光硬化性樹脂組成物、熱可塑性重合体または熱可塑性重合体組成物として、本発明第１方法で用いられる光硬化性樹脂組成物および本発明第２方法で用いられる熱可塑性重合体または熱可塑性重合体組成物と同じものが使用できる。本発明第３方法では、光硬化性樹脂組成物、熱可塑性重合体または熱可塑性重合体組成物という多種類の樹脂や重合体、重合体組成物を用いるものであるため、それらの２種以上の組み合わせとして極めて多様な組み合わせが可能であり、かかる点で、立体造形物の用途などに応じて、より精密な立体造形物を形成することができる。本発明第３方法では、マスクパターンの形成方法、光硬化および／または冷却固化した層の形成方法や形成装置、最終工程での立体造形物からの光硬化してない光硬化性樹脂組成物の分離方法などにおいても、本発明第１方法および／または本発明第２方法と同様の方法および装置が採用される。

【００３９】本発明第３方法を採用して生体模型を製造するに当たって、例えば、先に生体の輪郭部（体表部）を熱可塑性重合体または熱可塑性重合体組成物で製造すると、熱可塑性重合体または熱可塑性重合体組成物よりなる輪郭部が光硬化性樹脂組成物を体内の部分に保持するための堤となり、高価な光硬化性樹脂組成物を余分に供給する必要がなくなる利点がある。また、本発明第３方法によって、例えば体内の複数の組織を再現した生体模型を製造する際に、熱可塑性重合体または熱可塑性重合体組成物と光硬化性樹脂組成物とを交互に供給するようにプログラムすると、熱可塑性重合体または熱可塑性重合体組成物と光硬化性樹脂組成物とが互いに接着しにくい点を利用して、生体模型においてそれぞれの組織に相当する部位が密着して剥がれなくなるようなトラブルを回避することができる。

【００４０】

【実施例】以下に本発明を実施例により具体的に説明するが、本発明は実施例に限定されるものではない。以下の実施例１～３で用いた光硬化性樹脂組成物および／または熱可塑性重合体（熱可塑性重合体組成物）の内容を下記の表１および表２に示す。

【００４１】

【表１】

[光硬化性樹脂組成物]

| 記号 | 組　成<br>(質量部) | 相形態および物性 | | |
|---|---|---|---|---|
| | | 未硬化物<br>(25℃) | 未硬化物<br>(120℃) | 硬化物<br>(25℃) |
| A | MMA(100)、PMMA(10)、 | 固体状 | 液状 | 硬質、透明 |
| B | i-PMMA(5)、開始剤(3)<br>２EHA(100)、PMMA(10)、 | 固体状 | 液状 | 軟質、透明 |
| C | i-PMMA(5)、開始剤(3)<br>２EHA(100)、PMMA(10)、<br>i-PMA(5)、開始剤(3)、<br>赤色染料(1) | 固体状 | 液状 | 軟質、赤色 |

【００４２】　　＊　＊【表２】

[熱可塑性重合体および熱可塑性樹脂組成物]

| 記号 | 組　成<br>(質量部) | 状態<br>(25℃) | 流動開始温度<br>[℃] | 色相 |
|---|---|---|---|---|
| a | PE(100) | 硬質 | １００ | 半透明 |
| b | IR(100)、オイル(1000) | ゴム状 | １８０ | 透明 |
| c | IR(100)、オイル(1000)、赤色染料(1) | ゴム状 | １８０ | 赤色 |

【００４３】なお、上記の表１および表２に記載したモノマーまたは重合体の略号とその内容は次のとおりである。

・MMA：メタクリル酸メチルモノマー

・PMMA：ポリメタクリル酸メチル（株式会社クラレ製：パラペットＬＷ－１０００、シンジオタクチック割合６５％）

・ｉ－PMMA：アイソタクティック－ポリメタクリル酸メチル（ｔ－ブチルマグネシウムブロマイドを開始剤として用いてアニオン重合により製造したもの；アイソタクティック割合９０％）

・２EHA：　アクリル酸２－エチルヘキシルモノマー

・赤色染料：共立化学株式会社製「＃３１０」

・PE：ポリエチレン（日本ポリケム株式会社製「ノバテックＨＪ－２９０」）

・白色顔料：酸化チタン（石原産業株式会社製「タイペーク」）

・IR：ポリイソプレンゴム（株式会社クラレ製「ＩＲ－１０」）

・オイル：プロセスオイル（出光石油化学株式会社製「PW－３８０」）

【００４４】《実施例１》［病変部を有する肝臓模型の製造］

（１）　この実施例１では、２種類の光硬化性樹脂組成物、具体的には正常部に相当する部位用として光硬化性樹脂組成物Ｂ（軟質透明）を用いて、また病変部に相当する部位用として光硬化性樹脂組成物Ｃ（軟質赤色）を用いて、本発明第１方法に従って、図１に相当する病変部を有する肝臓に相当する肝臓模型を製造した。すなわち、加熱手段を有する２個の樹脂タンク、該２個の樹脂タンクと連結した上下動可能な造形ステージ（造形テーブル）上に光硬化性樹脂組成物を塗布可能な個別のＸ－Ｙプロッター装置に結合した２個のノズル、および紫外線遮光性インクを印刷できるＸ－Ｙプロッター装置に結合したインクジェットヘッドを主要駆動部として備え且つ紫外線ランプを光源として備える装置を用いて、図３～図５に示す手順に従って、病変部に相当する部位を正常部に相当する部位内に有する、図１の概略図で示される肝臓の模型を製造した。

【００４５】（２）　ＣＴスキャンにより得られた図１の概略図に示す病変部を有する、患者の肝臓データをコンピューターによりＳＴＬフォーマットに変換した後、さらに図２に示すようにコンピューターでスライスして各層のスライス形状データ（スライス断面データ）を求めた。

（３）　図２において、病変部を含まないスライス断面データは、ｎ＝１の第１層からｎ＝ｐの層までである。これらの層部分の光造形は、光硬化性樹脂組成物Ｂを単独で使用して、図３の概略図に示す方法で行った。すなわち、

（ｉ）　光硬化性樹脂組成物Ｂを１２０℃に加熱溶融してゾル状（液状）にしてノズル１から造形ステージ３の上に１層分供給し直ちに空冷によりゲル状にして（固化して）固化層４－１を形成する工程（図３の①）；

（ii）　前記で形成した固化層４－１の上に、スライス断面データに基づいてインクジェットヘッド５によって遮光性マスクパターン６－１を形成する工程（図３の②）；

（iii）　紫外線照射装置７によって面照射を行って層内に光硬化した樹脂部８－１を形成する工程（図３の③）；

（iv）　造形ステージ３を１層分だけ下降させた後、前記（iii）で形成した光硬化した樹脂部８－１を層内に含む層（ｎ＝１）の面上に、１２０℃に加熱して溶融した光硬化性樹脂組成物Ｂをノズル１から１層分供給し、直ちに空冷してゲル化して（固化して）固化層４－２を形成する工程（図３の④）；

（ｖ）　前記で生成した固化層４－２に対して各々のスライス断面データに基づいて、前記（ii）～（iv）の工程をｎ＝ｐの層が形成されるまで繰り返す工程;を採用してｎ＝１の第１層からｎ＝ｐの層までに相当する部分の光造形を行った。

【００４６】（４）　図２において、病変部を含むスライス断面データは、ｎ＝ｐ＋１からｎ＝ｑの層までである。そこで、上記（３）の光造形に続いて、ｎ＝ｐ＋１からｎ＝ｑの層までの光造形を、光硬化性樹脂組成物Ｂおよび光硬化性樹脂組成物Ｃの両方を使用して、図４の概略図に示す方法で行った。すなわち、

（ｉ）　各タンク内の光硬化性樹脂組成物Ｂおよび光硬化性樹脂組成物Ｃをそれぞれ１２０℃に加熱溶融してゾル状（液状）にしてノズル１およびノズル２から１層分で光硬化した樹脂部を含む層（ｎ＝ｐに相当する層）の上に供給し、直ちに空冷によりゲル状にして（固化して）、光硬化性樹脂組成物Ｂからなる部位と光硬化性樹脂組成物Ｃからなる部位とが１つの層内に分布した固化層４－$p_1$を形成する工程（図４の①’）；

（ii）　前記で生成した固化層４－$p_1$の上にスライス断面データに基づいたインクジェットヘッド５による遮光性マスクパターン６－$p_1$を形成する工程（図４の②’）；

（iii）　紫外線照射装置７により面照射して光硬化した樹脂部８－$p_1$を形成する工程（図４の③’）；

（iv）　造形ステージ３を１層分だけ下降させた後、前記（iii）で形成した光硬化樹脂部８－$p_1$を層内に含む層（ｎ＝ｐ＋１に相当する層）の面上に、１２０℃に加熱して溶融した光硬化性樹脂組成物Ｂと光硬化性樹脂組成物Ｃをノズル１およびノズル２を通して１層分供給し直ちに空冷によりゲル状にして（固化して）、光硬化性樹脂組成物Ｂ部と光硬化性樹脂組成物Ｃ部が１つの層内に分布した固化層４－$p_2$を形成する工程（図４の④’）；

（ｖ）　前記で生成した固化層４－$p_2$に対して各々スライス断面データに基づいて、前記（ii）～（iv）の工程をｎ＝ｑの層が形成するまで繰り返す工程；を採用してｎ＝ｐ＋１からｎ＝ｑの層までの部分（病変部に相当する部位を有する部分）の光造形を行った。

【００４７】（５）　上記の工程によって、図５の（ａ）に示すように、光硬化してない光硬化性樹脂組成物１０によって光硬化した樹脂からなる造形部９がほぼ包囲された造形体が得られたので、それを１２０℃で５分間加熱して未硬化の光硬化性樹脂組成物１０の部分を溶融して（ゾル状にして）造形物９から分離することによって、図５の（ｂ）に示す、病変部に相当する部位を有する肝臓模型が得られた。この肝臓模型では、病変部に相当する部位は軟質赤色であり、正常部に相当する部位は軟質透明であり、しかも両部位は生体肝臓と類似した弾性率を有しており、さらに病変部に相当する部位と正常部に相当する部位が色調が異なるものの同質の光硬化性樹脂組成物から形成されているため、病変部に相当する部位と正常部に相当する部位間の接着が良好であった。そして、この肝臓模型では、病変部に相当する部位の状態を外部から容易に確認することができるため、手術前のシミュレーションや医学生の教育などに極めて有用なものであった。

【００４８】《実施例２》［病変部を有する肝臓模型の製造］

（１）　この実施例２では、図１に相当する病変部を有する肝臓に相当する肝臓模型［図５の（ｂ）に示す肝臓模型］を、１種類の熱可塑性重合体と２種類の熱可塑性重合体組成物、具体的には表２におけるａ（サポート用；硬質半透明）、ｂ（正常部に相当する部位用；ゴム状透明）およびｃ（病変部に相当する部位用；ゴム状赤色））を使用して、本発明第２方法に従って製造した。その際にサポート部位を考慮して、図８に示す形状の立体造形物を製造し、それからサポート部を分離することによって、図５に示す肝臓模型を製造した。すなわち、加熱手段を有する３個の重合体タンク、該３個の重合体タンクと連結した上下動可能な造形ステージ（造形テーブル）上に熱可塑性重合体または熱可塑性重合体組成物を塗布可能な個別のＸ－Ｙプロッター装置に結合した３個のノズル、および冷却装置を主要駆動部として備える装置を用いて、図７に示す手順に従って、病変部に相当する部位を正常部に相当する部位内に有し且つサポート部を有する図８の概略図で示されるサポート付の立体造形物を製造した後、該立体造形物からサポート部を分離することによって、図５に示す肝臓模型を製造した。

【００４９】（２）　ＣＴスキャンにより得られた図１の概略図に示す病変部を有する、患者の肝臓データをコンピューターによりＳＴＬフォーマットに変換した後、さらに図６に示すようにコンピューターでスライスして各層のスライス形状データ（スライス断面データ）を求めた。図６において、病変部を含まず、サポート部と正常部を含むスライス断面データは、ｎ＝１の第１層からｎ＝ｐの層までである。これらの層部分の光造形は、熱

可塑性重合体ａ（サポート部用）と熱可塑性重合体組成物ｃ（正常部用）光硬化性樹脂組成物を使用して、図７の該略図に示す方法で行った。すなわち、

（ｉ）　第１のスライス断面データに基づいて、熱可塑性重合体ａを１１０℃に加熱溶融して流動状にしてノズル１１を通して造形ステージ３の上に供給し、同時に熱可塑性重合体組成物ｂを１９０℃に加熱溶融して流動状にしてノズル１２を通して造形ステージ３の上に供給し、直ちに冷却装置で冷却して固化させ、１つの層内に熱可塑性重合体ａからなる部位と熱可塑性重合体組成物ｂからなる部位とが分布している第１の固化層１４－１を形成する工程（図７の①）；

（ii）　造形ステージ３を１層分だけ下降させた後、前記（ｉ）で形成した固化層１４－１（ｎ＝１に相当する層）の面上に、第２のスライス断面データに基づいて、熱可塑性重合体ａを１１０℃に加熱溶融して流動状にしてノズル１１を通して供給し、同時に熱可塑性重合体組成物ｂを１９０℃に加熱溶融して流動状にしてノズル１２を通して供給し、直ちに冷却装置で冷却して固化させ、１つの層内に熱可塑性重合体ａからなる部位と熱可塑性重合体組成物ｂからなる部位とが分布している第２の固化層１４－２を形成する工程（図７の②）；

（iii）　前記で生成した固化層１４－２に対して各々のスライス断面データに基づいて、前記（ii）の工程をｎ＝ｐの層が形成されるまで繰り返す工程;を採用してｎ＝１の第１層からｎ＝ｐの層までに相当する部分の造形を行った。

【００５０】（３）　次に、造形ステージ３を１層分だけ下降させた後、前記（２）で形成した固化層１４－ｐ（ｎ＝ｐに相当する固化層）の上に、スライス断面データに基づいて、熱可塑性重合体組成物ｂを１９０℃に加熱溶融して流動状にしてノズル１２から供給し、直ちに冷却装置で冷却して固化させ、熱可塑性重合体組成物ｂのみからなる固化層（ｎ＝ｐ＋１に相当する固化層）を形成した（図７の③）。

（４）（ｉ）　続いて、造形ステージ３を１層分だけ下降させた後、前記（４）で形成した固化層（ｎ＝ｐ＋１に相当する固化層）の上に、スライス断面データに基づいて、熱可塑性重合体組成物ｂ（正常部に相当する部位用；透明）を１９０℃に加熱溶融して流動状にしてノズル１２を通して供給し、同時に熱可塑性重合体組成物ｃ（病変部に相当する部位用；赤色）を１９０℃に加熱溶融して流動状にしてノズル１３を通して供給し、直ちに冷却装置で冷却して固化させ、１つの層内に熱可塑性重合体組成物ｂからなる部位と熱可塑性重合体組成物ｃからなる部位とが分布している固化層（ｎ＝ｐ＋２に相当する固化層）を形成した。

（ii）　前記（ｉ）で生成した固化層に対して各々のスライス断面データに基づいて、前記（ｉ）と同様の工程をｎ＝ｑの層が形成されるまで繰り返す工程を採用して、図８に示すような、サポート部１５、正常部に相当する部位１６および病変部に相当する部位１７を有する立体造形物を製造した。

【００５１】（５）　上記（５）で得られた図８の立体造形物を１１０℃に加熱することによって、サポート部１５のみが溶融液化し、部位１６と部位１７からなる本体部から容易に分離して、図５の（ｂ）に示す、病変部に相当する部位を有する肝臓模型が得られた。この肝臓模型では、病変部に相当する部位は赤色であり、正常部に相当する部位は無色透明であり、しかも両部位は生体肝臓と類似した弾性率を有しており、さらに病変部に相当する部位と正常部に相当する部位が色調が異なるものの同質の熱可塑性重合体組成物から形成されているため、病変部に相当する部位と正常部に相当する部位間の接着が良好であり、病変部に相当する部位の状態を外部から容易に確認することができるため、手術前のシミュレーションや医学生の教育などに極めて有用なものであった。

【００５２】《実施例３》［筋肉相当部位と骨相当部位を有する生体模型の製造］

（１）　この実施例３では、光硬化性樹脂組成物Ａ（骨相当部位用；硬質透明）、光硬化性樹脂組成物Ｃ（筋肉相当部位用；軟式赤色）および熱可塑性重合体ａ（骨と筋肉との間の空間部相当部位用；硬質半透明）の３種類の重合体を用いて、本発明第３方法に従って、図９に相当する、筋肉相当部位と骨相当部位を有し且つ筋肉相当部位と骨相当部位との間に空間を有する生体模型を製造した。すなわち、加熱手段を有する３個の樹脂（重合体）タンク、上下動可能な造形ステージ（造形テーブル）上に光硬化性樹脂組成物および熱可塑性重合体を塗布可能な、前記３個のタンクと連結した個別のＸ－Ｙプロッター装置に結合した３個のノズル、紫外線遮光性インクを印刷できるＸ－Ｙプロッター装置に結合したインクジェットヘッドおよび冷却装置を主要駆動部として備え、紫外線ランプを光源として備える装置を用いて、以下の（２）以降に示す工程で、図９に相当する筋肉相当部位と骨相当部位を有する生体模型を製造した。

【００５３】（２）　ＣＴスキャンにより得られた生体部データをコンピューターによりＳＴＬフォーマットに変換した後、さらに図１０に示すようにコンピューターでスライスして各層のスライス形状データ（スライス断面データ）を求めた。

（３）　上記（２）で得られたスライス断面データに基づいて、１つの層内に筋肉に相当する部分のみを有する層（図１０におけるｎ＝１～ｎ＝ｐのスライス断面データに相当する層）での造形は、光硬化性樹脂組成物Ｃのみを用いて、実施例１の（３）におけるのと同様の工程を採用して行った。

（４）　次に、１つの層内に筋肉に相当する部位、空間に相当する部位および骨に相当する部位を有する層（図

１０におけるｎ＝ｐ＋１～ｎ＝ｑのスライス断面データに相当する層）での造形は、光硬化性樹脂組成物Ａ、光硬化性樹脂組成物Ｃおよび熱可塑性重合体ａを用いて、実施例１の（４）におけるのと同様の工程を採用して行った。

（５）　続いて、１つの層内に骨に相当する部位と空間に相当する部位を有する層（図１０におけるｎ＝ｑ＋１～ｎ＝ｒのスライス断面データに相当する層）での造形は、光硬化性樹脂組成物Ａと熱可塑性重合体ａを用いて実施例１の（４）におけるのと同様の工程を採用して行った。

【００５４】（６）　次に、１つの層内に骨に相当する部位のみを有する層（図１０におけるｎ＝ｒ＋１以降のスライス断面データに相当する層）での造形は、光硬化性樹脂組成物Ａのみを用いて実施例１の(３)におけるのと同様の工程を採用して行った。

（７）　上記の工程によって、図１１に示すように、光硬化してない光硬化性樹脂組成物１０によって光硬化した樹脂と固化した熱可塑性重合体からなる造形部がほぼ包囲された造形体が得られたので、それを１２０℃で５分間加熱して、未硬化の光硬化性樹脂組成物１０の部分と空間部に相当する熱可塑性重合体ａを溶融して造形物から分離することによって、図９に相当する、筋肉相当部位と骨相当部位を有し且つ筋肉相当部位と骨相当部位との間に空間を有する生体模型を製造した。この生体模型では、筋肉相当部位は軟質赤色であり、骨相当部位が硬質透明であり、しかも生体におけるのと同様に筋肉相当部位と骨相当部位との間に空間が存在しているため、生体における実際の組織構造を容易に且つ確実に知ることができる。

【００５５】

【発明の効果】本発明による場合は、１つの立体造形物中に、例えば、色調、透明度、力学的特性、物理的特性、化学的特性などが異なる複数の部位が複合的に形成されていて、工業分野、医療分野、その分野など各種用途に有効に用い得る精密な立体造形物を、迅速に且つ高い造形精度で生産性よく製造することができる。本発明の方法は、生体模型の製造に特に適しており、例えば、特定の患部だけを再現した生体模型；トルソ像や頭像など生体模型；患部組織の形態を忠実に再現した生体模型であって組織内の正常な部分と切除すべき病変部分とが互いに識別可能な色調などで作製生体模型；透明な樹脂よりなる生体の全身模型または部分模型の中に他の部分とは異なった色調の患部組織が埋まっている形式の生体模型；透明な樹脂よりなる生体の全身模型または部分模型の中に医師が内視鏡を患部に向かって挿入せんとする際に内視鏡が接近または接触する可能性のある複数の組織および目的とする患部が互いに他の部分とは識別可能な色調の樹脂で作成されているような生体模型；生体組織に似せた弾性率などの力学特性を有する複数の樹脂や重合体からなる患部組織をより忠実に再現した生体模型などの種々の精密な生体模型を迅速に且つ容易に製造することができる。そのため、本発明の方法により得られる生体模型は、術前の医師の練習用（シミュレーション用）、イメージトレーニング用、医学生や看護学生の教育や訓練用などとして極めて有用である。そして、本発明第１方法による場合は、光造形工程を複雑にする別体のサポートや立体造形物におけるサポート付けなどが不要であり、目的とする前記した各種の立体造形物を、簡単に製造することができる。

【図面の簡単な説明】

【図１】病変部を有する肝臓の例を示す概略図である。

【図２】図１の肝臓のデータから得られる各層のスライス形状データ（スライス断面データ）を示す図である。

【図３】実施例１で本発明第１方法によって図１の肝臓に相当する肝臓模型を製造する際の前般の工程を示す図である。

【図４】実施例１で本発明第１方法によって図１の肝臓に相当する肝臓模型を製造する際の中盤以降の工程を示す図である。

【図５】実施例１で本発明第１方法によって図１の肝臓に相当する肝臓模型を製造する際の最後の工程と、最終的に得られた肝臓模型を示す図である。

【図６】実施例２で採用いられた、図１の肝臓のデータから得られる各層のスライス形状データ（スライス断面データ）（サポート部付）を示す図である。

【図７】実施例２で本発明第２方法によって図１の肝臓に相当する肝臓模型を製造する際の工程を示す図である。

【図８】実施例２で本発明第２方法を採用して得られたサポート付きの肝臓模型の概略を示す図である。

【図９】実施例３で本発明第３方法を採用して得られた筋肉相当部位と骨相当部位を有する生体模型の概略を示す図である。

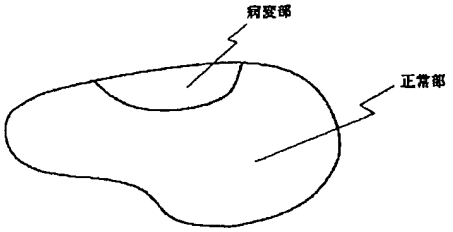
【図１０】実施例３で用いられた、図９の生体模型を得るための各層のスライス形状データ（スライス断面データ）を示す図である。

【図１１】実施例３で得られた、光硬化してない光硬化性樹脂組成物でほぼ包囲された立体造形物を示す図である。

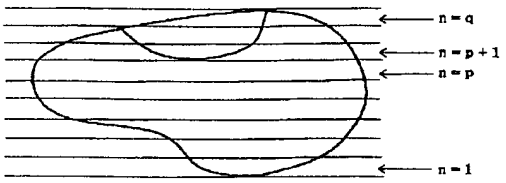
【符号の説明】

１　ノズル
２　ノズル
３　造形ステージ
５　光遮蔽用インクジェットヘッド
７　紫外線照射装置
１１　ノズル
１２　ノズル
１３　ノズル

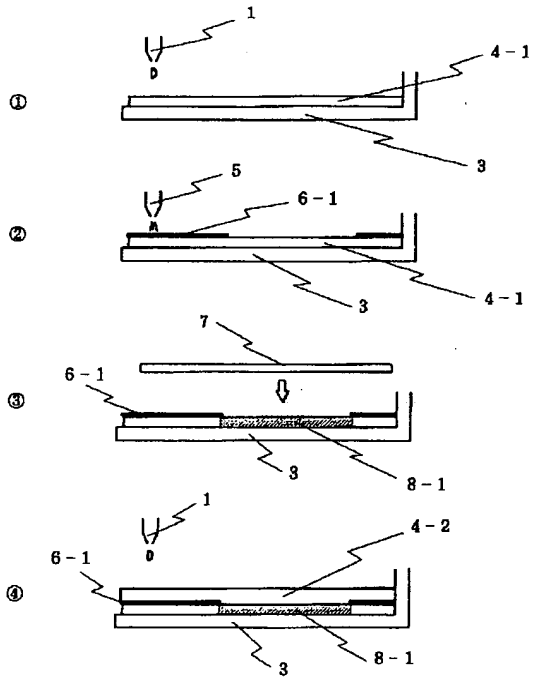
【図１】



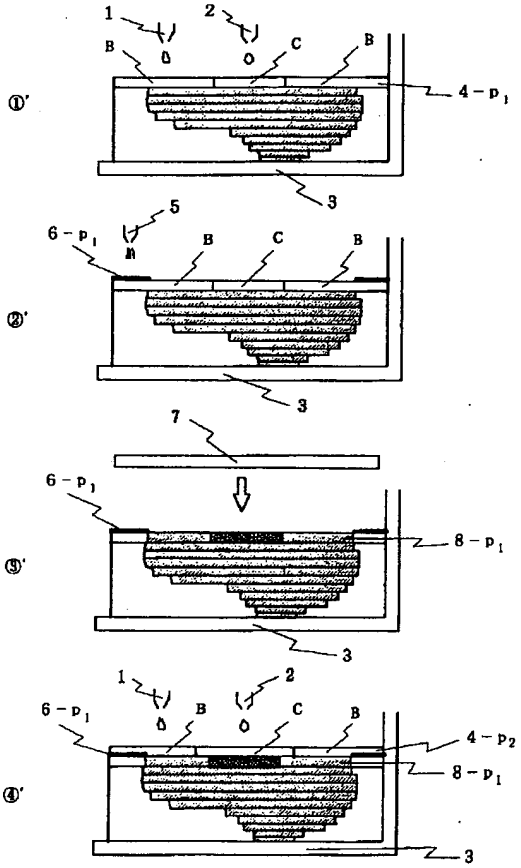

【図２】



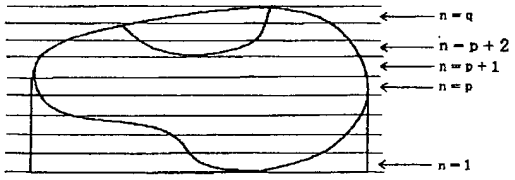

【図３】



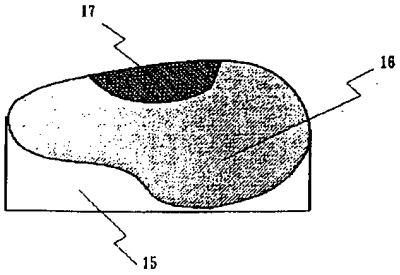

【図４】



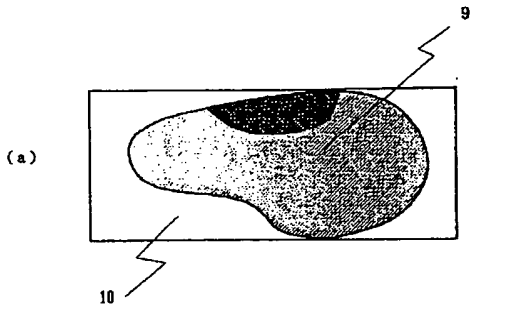

【図６】



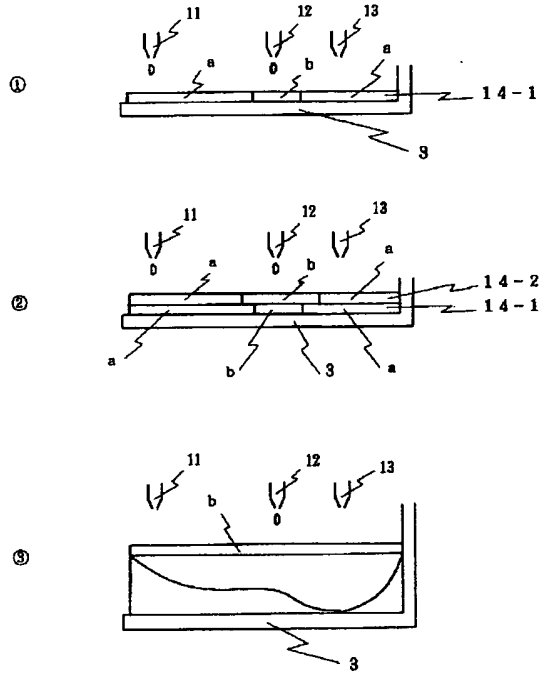

【図８】



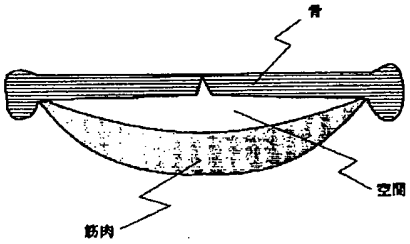
【図５】



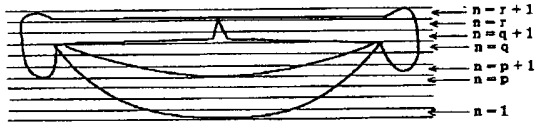

【図７】



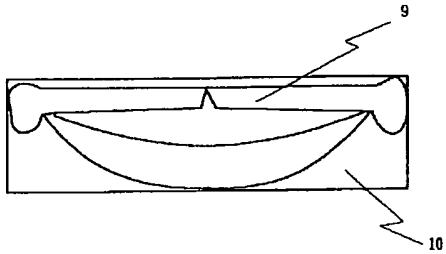

【図９】




【図１０】




【図１１】




---

フロントページの続き

(72)発明者　井出　章子
大阪府大阪市北区梅田１丁目12番39号　株式会社クラレ内
(72)発明者　柏田　達彦
大阪府大阪市北区梅田１丁目12番39号　株式会社クラレ内

Ｆターム(参考)　2H097 CA11 FA02 GA50 HA00 LA15
4F213 AA44 WA25 WA84 WB01 WL03 WL12 WL15 WL24 WL34 WL67 WL82
5H269 AB01 BB03 BB05 CC01 DD01 QA05 QE06

(11)Publication number : 2003-011237

(43)Date of publication of application : 15.01.2003

(51)Int.Cl. B29C 67/00

G03F 7/20

G05B 19/4097

(21)Application number : 2001-201961

(22)Date of filing : 03.07.2001

(71)Applicant : KURARAY CO LTD

(72)Inventor : HINO KENICHI
ISHIURA KAZUNARI
IDE AKIKO
HIGAKI TATSUHIKO

# (54) METHOD FOR PRODUCING THREE-DIMENSIONAL SHAPED ARTICLE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method for producing a precision three-dimensional shaped article especially suitable for a living body model in which a plurality of parts different in color tone, transparency, mechanical properties, physical properties, chemical properties, biochemical properties, etc., are formed compositely.

SOLUTION: The three-dimensional shaped article is produced by a method for optical three-dimensional shaping by using at least two photo-curable resin compositions capable of reversible sol-gel phase transition by the change of temperature or a method for optical three-dimensional shaping by using at least two thermoplastic polymers or thermoplastic polymer compositions 60-200°C in flow starting temperature, or by combining the two methods.

## CLAIMS

[Claim(s)]

[Claim 1] Two or more kinds of photo-setting resin constituents which cause sol-gel phase transition reversibly and quickly by the temperature change are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. this -- 1 of two or more kinds of photo-setting resin constituents, or two kinds or more While supplying Taira and others by one layer above the area which said slice configuration data occupy by the shape of a sol, cooling gelation is carried out immediately. After giving a mask pattern to the part in this photo-setting resin constituent layer which carries out photo-curing, On said resin layer including the part which was made to carry out photo-curing of the part where light is irradiated and the mask pattern is not given, and subsequently carried out photo-curing Or while newly supplying two or more kinds to Taira and others by one layer by the shape of a sol, cooling gelation is carried out immediately. the following slice configuration data which come to slice three-dimensions data by computer in parallel -- being based -- one kind in said photo-setting resin constituent carried out -- After giving a mask pattern to the part in this photo-setting resin constituent layer which carries out photo-curing, irradiate light and a resin layer including the part which was made to carry out photo-curing of the part where the mask pattern is not given, and carried out photo-curing is made to form. The manufacture

approach of the solid molding object characterized by removing a multiple-times repeat and the photo-setting resin constituent by which photo-curing subsequently was not carried out from said stereo-like photo-curing object for said actuation until the stereo-like photo-curing object equivalent to three-dimensions data is formed.

[Claim 2] Two or more kinds of the thermoplastic polymers or the thermoplastic polymer constituents in the range whose flow beginning temperature is 60-250 degrees C are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. this -- one kind in two or more kinds of thermoplastic polymers, or a thermoplastic polymer constituent, or two kinds or more While supplying Taira and others by one layer in the state of a flow from the nozzle which it comes to prepare in the X-Y plotter equipment according to individual, cooling solidification is carried out immediately. Subsequently, on this layer that carried out cooling solidification Or while newly supplying two or more kinds to Taira and others by one layer in the state of a flow, cooling solidification is carried out immediately. the following slice configuration data which come to slice three-dimensions data by computer in parallel -- being based -- one kind in said thermoplastic polymer carried out or a thermoplastic polymer constituent -- The manufacture approach of the solid molding object characterized by repeating said actuation two or more times until the stereo-like solidification object equivalent to three-dimensions data is formed.

[Claim 3] One or more kinds of the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change, One or more kinds of the thermoplastic polymer in the range whose flow beginning temperature is 60-250 degrees C, or a thermoplastic polymer constituent are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. While supplying one kind in the above mentioned photo-setting resin constituent, a thermoplastic polymer, and a thermoplastic polymer constituent, or two kinds or more to Taira and others by one layer above the area which said slice configuration data occupy in the state of the shape of a sol, and a flow, cool immediately and it is made to gel and/or solidify. After giving a mask pattern to the part in this layer which carries out photo-curing, Irradiate light and photo-curing of the photo-setting resin constituent part where the mask pattern is not given is carried out. Subsequently, on said layer including the part which carried out photo-curing Three-dimensions data by computer the following slice configuration data which it comes to slice in parallel -- being based -- one kind in said photo-setting resin constituent carried out and thermoplastic polymer, or a thermoplastic polymer constituent -- or, while newly supplying two or more kinds to Taira and others by one layer in the state of the shape of a sol, and a flow After cooling immediately, making it gel and/or solidify and giving a mask pattern to the part in this layer which carries out photo-curing, irradiate light and a layer including the part which was made to carry out photo-curing of the photo-setting resin constituent part where the mask pattern is not given, and carried out photo-curing is made to form. The manufacture approach of the solid molding object characterized by removing a multiple-times repeat and the photo-setting resin constituent by which photo-curing subsequently was not carried out from a stereo-like object for said actuation until the stereo-like object equivalent to three-dimensions data is formed.

[Claim 4] The manufacture approach according to claim 1 or 3 given by carrying out jet injection of the light impermeability nature ink on the layer which gelled and/or solidified the mask pattern.

[Claim 5] As one or more kinds of one or more kinds and the thermoplastic polymer of two or more kinds of photo-setting resin constituents, two or more kinds of thermoplastic polymers, a thermoplastic polymer constituent, or a photo-setting resin constituent, or a thermoplastic polymer constituent The manufacture approach given in any 1 term of claims 1-4 using what forms a mutually different part in at least one of a presentation, a color tone, transparency, kinetic property, a physical characteristic, and chemical property into the solid molding object manufactured.

[Claim 6] The manufacture approach given in any 1 term of claims 1-5 said whose slice configuration data are tomography data obtained from a living body's some or the whole body and whose solid molding objects are living body models.
[Claim 7] The solid molding object obtained by the manufacture approach given in any 1 term of claims 1-6.
[Claim 8] The solid molding object according to claim 7 which is a living body model.
[Claim 9] The solid molding object according to claim 8 which is the living body model which reproduced the gestalt of an affected part organization faithfully.
[Claim 10] The solid molding object according to claim 9 currently formed from the photo-curing resin or the thermoplastic polymer which has the color tone to which the part equivalent to the affected part organization in a living body model differed from normal tissue, transparency, kinetic property, and/or a physical characteristic.
[Claim 11] The solid molding object according to claim 8 with which the part equivalent to a different body tissue in a living body model is formed from the photo-curing resin or the thermoplastic polymer with which a color tone, transparency, and kinetic property differ from a physical characteristic.

---

DETAILED DESCRIPTION

---

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the solid molding object obtained by that cause by the approach the part which consists of the part and/or each thermoplastic polymer which consist of each resin constituent manufactures quickly the solid molding object compound-ized in three dimensions in one solid molding object to a precision, and the list using two or more kinds of photo-setting resin constituents and/or thermoplastic polymers (thermoplastic polymer constituent). Especially the approach of this invention is useful as a manufacturing method of a living body model, and the solid molding object obtained by this invention, especially a living body model can be used from reproducing a living body's condition correctly effective in the applications for the medical simulation for the check before an operation by education and training of a medicine student, and the medical practitioner, or practice etc., for example.
[0002]
[Description of the Prior Art] Conventionally, the living body model used for the medical-application simulation a check before an operation, for practice, etc. by education and training of a medicine student, and the medical practitioner belonged to the mannequin with the inorganic most. Moreover, it is produced using the elasticity elastomer and the elastic doll which has the internal structure which is equivalent to a trachea, lungs, or the heart depending on the case, a tube containing simulation blood, etc. is used for training of lifesaving revival, practice of an intravenous injection, etc. in recent years. However, no they are what does not come out of the region of the uniform mannequin made based on the data of typical anatomy, and reproduced faithfully each focus situation peculiar to a patient and living body gestalt. Therefore, although it was helpful to practice of a medical aid procedure, for [ the check before an operation by the medical practitioner, for practice, etc. ] medical-application simulation, it was not fully utility.
[0003] Moreover, since there are few damages given to a patient as compared with the usual surgical operation in recent years, the method of operation using an endoscope progresses and it is in the limelight. Although undergoing an operation, photoing the affected part and looking at the image in an endoscopic operation is also performed, since it is not that on which unlike a surgical operation an operation is

performed while viewing the affected part directly, high skill level is required. Then, although request of wanting SHIMYURESHONSHI several times is strong before actually performing an endoscopic operation, the actual condition is not realized from there being no living body model which reproduced each patient's affected part situation faithfully.

[0004] The Mitsuzo form approach which forms a molding object on the other hand by repeating actuation of irradiating light and stiffening it after drawing a mask pattern to the part which gives at a time one layer of one kind of photo-setting resin constituent which causes sol-gel phase transition in the international public presentation WO 01/No. 10632 official report reversibly and quickly by physical changes, such as temperature, in the shape of a layer, and carries out photo-curing is indicated. Although a Mitsuzo form object can be quickly manufactured, without arranging a support when based on this approach Since the Mitsuzo form is performed using one kind of photo-setting resin constituent For example, the part equivalent to the affected part and the part equivalent to normal tissue cannot manufacture the highly efficient living body model which it is formed possible [ distinction ] into one solid molding object, it is compound-ized, and can be used effective in the simulation in the medical field etc. and applying that optical solid molding method to production of general industrial use articles, such as a gearing, is only indicated by this official report, and it applies to production of a living body model -- it is not indicated even things.

[0005] Moreover, although the optical solid molding method for manufacturing a solid molding object not only using the approach indicated by the above-mentioned international public presentation official report but using a photo-setting resin constituent is variously learned also from the former Since molding is performed only using one kind of photo-setting resin constituent also in the conventional optical solid molding method, it cannot fully apply that the distinguishable part is mutually formed complexly into one solid molding object to manufacture of the living body model currently called for strongly. Furthermore, although the solid molding object with which two or more parts where a color tone and kinetic property differ from a physical characteristic etc. are complexly formed into one molding object also not only in a living body model but in the Mitsuzo form object used as an industrial components model etc. may be required It was difficult to manufacture such a molding object by the conventional optical solid molding method for performing optical solid molding only using one kind of photo-setting resin constituent.

[0006]

[Problem(s) to be Solved by the Invention] The purpose of this invention is offering the solid molding method for the ability manufacturing the solid molding object with which two or more parts where a color tone, transparency, kinetic property, and a physical characteristic differ from chemical property etc. are complexly formed into one solid molding object in a quick and high molding precision. Especially this invention sets it as the important purpose to offer the solid molding method for the ability to manufacture the living body model of the condition more near the living body of thing with sufficient productivity as a living body model used for a medicine student's practice teaching, training, medical-application simulation, etc. And the purpose of this invention is offering the living body model and the other solid molding objects with which two or more parts where a color tone, transparency, kinetic property, and a physical characteristic differ from chemical property etc. are formed precisely and complexly into one solid molding object.

[0007]

[Means for Solving the Problem] [ whether this invention persons perform two or more kinds of specific optical solid molding methods using the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change, as a result of inquiring wholeheartedly, in order to solve the above-mentioned technical problem, and ] [ whether solid molding is performed by the specific approach using two or more kinds of the thermoplastic polymers or the thermoplastic polymer constituents in the range whose flow beginning temperature is 60-250 degrees C, and ] When solid molding is performed by the

specific approach using one or more kinds of the thermoplastic polymer in within the limits whose one or more kinds and flow beginning temperature of the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change are 60-250 degrees C, or a thermoplastic polymer constituent, or a color tone, Two or more different parts, such as transparency, kinetic property, a physical characteristic, and chemical property, can manufacture the solid molding object currently complexly formed into one molding object in a quick and high molding precision, And especially these solid molding methods found out that it was effective as the manufacture approach of a living body model, and completed this invention.

[0008] Namely, this invention (1) Two or more kinds of photo-setting resin constituents which cause sol-gel phase transition reversibly and quickly by the temperature change are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. this -- 1 of two or more kinds of photo-setting resin constituents, or two kinds or more While supplying Taira and others by one layer above the area which said slice configuration data occupy by the shape of a sol, cooling gelation is carried out immediately. After giving a mask pattern to the part in this photo-setting resin constituent layer which carries out photo-curing, On said resin layer including the part which was made to carry out photo-curing of the part where light is irradiated and the mask pattern is not given, and subsequently carried out photo-curing Or while newly supplying two or more kinds to Taira and others by one layer by the shape of a sol, cooling gelation is carried out immediately. the following slice configuration data which come to slice three-dimensions data by computer in parallel -- being based -- one kind in said photo-setting resin constituent carried out -- After giving a mask pattern to the part in this photo-setting resin constituent layer which carries out photo-curing, irradiate light and a resin layer including the part which was made to carry out photo-curing of the part where the mask pattern is not given, and carried out photo-curing is made to form. It is the manufacture approach (it may be called below "the 1st approach of this invention") of the solid molding object characterized by removing a multiple-times repeat and the photo-setting resin constituent by which photo-curing subsequently was not carried out from a stereo-like photo-curing object for said actuation until the stereo-like photo-curing object equivalent to three-dimensions data is formed.

[0009] And this invention (2) Two or more kinds of the thermoplastic polymers or the thermoplastic polymer constituents in the range whose flow beginning temperature is 60-250 degrees C are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. this -- one kind in two or more kinds of thermoplastic polymers, or a thermoplastic polymer constituent, or two kinds or more While supplying Taira and others by one layer in the state of a flow from the nozzle which it comes to prepare in the X-Y plotter equipment according to individual, cooling solidification is carried out immediately. Subsequently, on this layer that carried out cooling solidification Or while newly supplying two or more kinds to Taira and others by one layer in the state of a flow, cooling solidification is carried out immediately. the following slice configuration data which come to slice three-dimensions data by computer in parallel -- being based -- one kind in said thermoplastic polymer carried out or a thermoplastic polymer constituent -- It is the manufacture approach (it may be called below "the 2nd approach of this invention") of the solid molding object characterized by repeating said actuation two or more times until the stereo-like solidification object equivalent to three-dimensions data is formed.

[0010] Furthermore, this invention (3) One or more kinds of the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change, One or more kinds of the thermoplastic polymer in the range whose flow beginning temperature is 60-250 degrees C, or a thermoplastic polymer constituent are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. While supplying one kind in the above mentioned photo-setting resin constituent, a thermoplastic polymer, and a thermoplastic polymer constituent, or two

kinds or more to Taira and others by one layer above the area which said slice configuration data occupy in the state of the shape of a sol, and a flow, cool immediately and it is made to gel and/or solidify. After giving a mask pattern to the part in this layer which carries out photo-curing, Irradiate light and photo-curing of the photo-setting resin constituent part where the mask pattern is not given is carried out. Subsequently, on said layer including the part which carried out photo-curing Three-dimensions data by computer the following slice configuration data which it comes to slice in parallel -- being based -- one kind in said photo-setting resin constituent carried out and thermoplastic polymer, or a thermoplastic polymer constituent -- or, while newly supplying two or more kinds to Taira and others by one layer in the state of the shape of a sol, and a flow After cooling immediately, making it gel and/or solidify and giving a mask pattern to the part in this layer which carries out photo-curing, irradiate light and a layer including the part which was made to carry out photo-curing of the photo-setting resin constituent part where the mask pattern is not given, and carried out photo-curing is made to form. It is the manufacture approach (it may be called below "the 3rd approach of this invention") of the solid molding object characterized by removing a multiple-times repeat and the photo-setting resin constituent by which photo-curing subsequently was not carried out from a stereo-like object for said actuation until the stereo-like object equivalent to three-dimensions data is formed.

[0011] And this invention (4) Above (1) or manufacture approach [ of (3) ]; given by carrying out jet injection of the light impermeability nature ink on the layer which gelled and/or solidified the mask pattern (5) Two or more kinds of photo-setting resin constituents, As one or more kinds of one or more kinds and the thermoplastic polymer of two or more kinds of thermoplastic polymers, a thermoplastic polymer constituent, or a photo-setting resin constituent, or a thermoplastic polymer constituent manufacturing -- having -- a stereo -- molding -- an object -- inside -- a presentation -- a color tone -- transparency -- kinetic property -- a physical characteristic -- and -- chemical property -- inside -- at least -- one -- a ** -- setting -- mutual -- differing -- a part -- forming -- a thing -- using -- said -- having carried out -- (-- one --) - (-- four --) -- either -- manufacture -- an approach --; -- and (6) One manufacture approach; of aforementioned (1) - (5) said whose slice configuration data are tomography data obtained from a living body's some or the whole body and whose solid molding objects are living body models is included.

[0012] Furthermore, this invention (7) Solid molding object; (8) obtained by one manufacture approach of aforementioned (1) - (6) Solid molding object [ of the above (7) which is a living body model ]; (9) Solid molding object [ of the above (8) which is the living body model which reproduced the gestalt of an affected part organization faithfully ]; (10) The color tone to which the part equivalent to the affected part organization in living body model differed from normal tissue, The solid molding object of the above (9) currently formed from the photo-curing resin or the thermoplastic polymer which has transparency, kinetic property, and/or a physical characteristic; It reaches. (11) The part equivalent to a different body tissue in a living body model is solid molding object [ of the above (8) currently formed from the photo-curing resin or the thermoplastic polymer with which a color tone, transparency, and kinetic property differ from a physical characteristic ];.

[0013]

[Embodiment of the Invention] This invention is explained below at a detail. With first, "the slice configuration data which comes to slice three-dimensions data by computer in parallel" which is the master data at the time of performing the 1st approach of this invention, the 2nd approach of this invention, and the 3rd approach (it being called the "this invention approach" when naming these generically below) of this invention 3-dimensional CAD data, the three-dimensions data which measure specific goods by the three dimensional measurer, and are obtained, Each slice configuration data (slice cross-section data) which slice thinly in parallel the three-dimensions data which photo some or all of a living body with tomographic

equipment (CT scanner etc.), and are obtained by computer in order to perform solid molding, and are obtained are said. When manufacturing a living body model by this invention approach, it is adopted as data for each slice configuration data which slice thinly in parallel the three-dimensions data which photo some or all of a living body with tomographic equipment (CT scanner etc.), and are obtained as these slice configuration data by computer, and are obtained to form the photo-curing resin layer or solidification polymer layer in every layer. X-ray CT scan image data, such as the affected part, is more specifically changed into an STL format (method which approximates a three-dimensions free sculptured surface with the aggregate of a triangular patch) within a computer. Based on affected part STL data, according to the resin to be used, the class of polymer, etc., arrangement within molding equipment, the direction of a laminating (how to place a model), etc. are determined, and when a support is required, data are separately produced within a computer, and it adds to affected part model three-dimensions data. Furthermore, affected part model three-dimensions data with a support are sliced within a computer by the case, and it asks for the cross-section data (contour-line data) of each class, and let this be slice configuration data at the time of performing solid molding.

[0014] (I) -- 1st approach [ of this invention ]: -- the 1st approach of this invention is explained first. The 1st approach of this invention is an approach of performing an optical exposure and manufacturing a solid molding object, after giving a mask pattern to the part which carries out photo-curing using the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change, and it is common in the approach currently indicated by the international public presentation WO 01/No. 10632 official report described above at this point. However, to making it indispensable to use two or more kinds of photo-setting resin constituents, by the approach indicated by the international public presentation WO 01/No. 10632 official report, the 1st approach of this invention uses only one kind of photo-setting resin constituent, and is greatly different with this point. When based on the 1st approach of this invention using two or more kinds of photo-setting resin constituents Although the precise solid molding object by which the part where a color tone, transparency, kinetic property, and a physical characteristic differ from chemical property was complexly formed into one molding object depending on how to combine two or more kinds of photo-setting resin constituents to be used can be formed By the approach given in the international public presentation WO 01/No. 10632 official report, the solid molding object with which such [ as mentioned above ] a different part is complexly formed into one solid molding object is not formed.

[0015] By the 1st approach of this invention, two or more kinds of photo-setting resin constituents which cause sol-gel phase transition reversibly and quickly by the temperature change are used first. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. this -- 1 of two or more kinds of photo-setting resin constituents or two kinds or more are heated to the temperature which presents the shape of a sol, and it is made the shape of a sol (making it a fluidity), and supplies by one layer on a molding stage (molding table) in Taira and others above the area which said slice configuration data occupy. Under the present circumstances, it depends on the contents [ whether it is alike and only one kind of photo-setting resin constituent is supplied in said formation for one layer, or two or more kinds of photo-setting resin constituents are supplied ] of the slice configuration data used as the base at the time of forming this layer. in being the contents of data which slice configuration data become from one homogeneity part on the whole except for the profile of the outside (in for example, the case of the slice configuration data equivalent to n= 1 in drawing 2 ), only one kind of photo-setting resin constituent supplies -- having -- this -- the stratification for one layer is made. moreover, when slice configuration data are the contents of data which are heterogeneity mutually and which have two or more parts (in for example, the case of the slice configuration data equivalent to n=p +1 in drawing 2 ) One (distributed) layer which was supplied separately,

respectively, without mixing beforehand a number equivalent to [ two or more ] a part of photo-setting resin constituents [ two or more kinds of ] which are this heterogeneity, and has been arranged in each location in one layer according to the contents of slice configuration data is formed. Said one layer which supplied one kind or two kinds or more of photo-setting resin constituents, and was formed is cooled and gelled immediately below at the setting temperature. especially -- this -- the case where one layer is formed from two or more kinds of photo-setting resin constituents -- this -- it is necessary to gel promptly so that mixing between two or more photo-setting resin constituents within one layer may not arise

[0016] Subsequently, in said one layer which consists of photo-setting resin constituents, after giving a mask pattern to the part which carries out photo-curing, light is irradiated and photo-curing of the part where the mask pattern is not given is carried out. Then, on said resin layer including the part which carried out photo-curing Or while newly supplying two or more kinds to Taira and others by one layer by the shape of a sol, cooling gelation is carried out immediately. the following slice configuration data which come to slice three-dimensions data by computer in parallel -- being based -- one kind in said photo-setting resin constituent carried out -- After giving a mask pattern to the part in this photo-setting resin constituent layer which carries out photo-curing, light is irradiated and a resin layer including the part which was made to carry out photo-curing of the part where the mask pattern is not given, and carried out photo-curing is made to form. And the actuation described above until the stereo-like photo-curing object equivalent to three-dimensions data was formed is repeated two or more times. Finally, the photo-setting resin constituent by which photo-curing was not carried out is removed from the stereo-like photo-curing object generated above, and the solid molding object made into the purpose is obtained.

[0017] as the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change used by the 1st approach of this invention -- 60-200 degrees C -- especially -- the inside of a 80-150-degree C temperature requirement -- reversible -- and -- rapid -- the gel from a sol -- or the photo-setting resin constituent which causes phase transition from gel to a sol is preferably used from points, such as the formation ease of each class it is difficult from a photo-setting resin constituent, and the ease of the gelation after forming this layer. The photo-setting resin constituent used by the 1st approach of this invention contains the component for fluid accommodation and photopolymerization initiator for generally carrying out sol-gel phase transition of the photoresist component and photo-setting resin constituent which consist of photoresist oligomer and/or a monomer reversibly by the temperature change, and contains the other additives for resin, for example, a thixotropy nature manifestation agent, a bulking agent, a plasticizer, a stabilizer, a coloring agent, a flame retarder, an antioxidant, an antistatic agent, etc. if needed further.

[0018] As the above-mentioned photoresist component which constitutes the photo-setting resin constituent used by the 1st approach of this invention It can be used. both the photoresist oligomer used from the former in the photo-setting resin constituent, and/or a monomer -- although -- For example, the alkyl (meta) acrylate system of monofunctional or many organic functions, an epoxy (meta) acrylate system, A polyester (meta) acrylate system, a polyether (meta) acrylate system, The photoresist monomers and photoresist oligomer of an acrylate (meta) system, such as an urethane (meta) acrylate system; The bisphenol A system epoxy compound, A novolak system epoxy compound, an alicyclic epoxy compound, a polyphenol system epoxy compound, An epoxy system light cation hardenability resinous principle with conventionally well-known a poly glycidyl amine system, an alcoholic system epoxy compound, an ester system epoxy compound, etc. can be mentioned, and those one sort or two sorts or more can be used.

[0019] As a component for fluid accommodation for carrying out sol-gel phase transition of the photo-setting resin constituent reversibly by the temperature change, a polymer is used preferably. The photoresist component which consists of photoresist oligomer and/or a monomer It will be in the condition of having swollen without dissolving the polymer which is a component for fluid accommodation when it becomes

below predetermined temperature. The whole photo-setting resin constituent gel in **** On the other hand, if the temperature of a photo-setting resin constituent turns into below predetermined temperature, a photoresist component will dissolve a polymer, or a polymer will fuse, and the whole photo-setting resin constituent will come to present a fluidity (the shape of a sol). A photo-setting resin constituent causes sol-gel phase transition reversibly by the temperature change with such a device.

[0020] As a polymer used as a component for fluid accommodation For example, the above mentioned homopolymer and above mentioned copolymer of a photoresist monomer, polybutadiene, Polyisoprene, polychloroprene, a polyvinyl chloride, polystyrene, The poly caprolactone, nitrile rubber, nylon, polyurethane, cel low SUTORI butyrate, A cel roast RINITO rate, polyethylene oxide, polyoxymethylene, A polyacrylonitrile, a collagen, polyvinyl alcohol, a polyvinylidene chloride, A polyvinyl butyral, an epoxy resin, a Polly 4-methyl pentene, Polyester, phenol resin, a urea-resin, melanin resin, diallyl phthalate resin, General-purpose polymers, such as silicone resin, a copolymer including the repeat unit which constitutes these polymers, Various kinds of bridge formation objects of said polymer or a copolymer, two or more sorts of those blend objects, the mixture of syndiotactic poly alkyl methacrylate and isotactic poly alkyl methacrylate, etc. can be mentioned. among those -- also coming out -- in this invention, the thing containing the mixture of syndiotactic poly alkyl methacrylate and isotactic poly alkyl methacrylate, especially the mixture of syndiotactic polymethylmethacrylate and isotactic polymethylmethacrylate is preferably used as a component for fluid accommodation.

[0021] Here, as the above mentioned syndiotactic polymethylmethacrylate, that whose percentage of three syndiotactic latticeworks (three continuous monomeric units) is about 60 - 90% is preferably used into a polymer, and what is about 65 - 80% is used more preferably. Moreover, as the above mentioned isotactic polymethylmethacrylate, that whose percentage of three isotactic latticeworks is about 80 - 95% is used desirable into a polymer, and what is about 85 - 95% is used more preferably. Syndiotactic polymethylmethacrylate: Although the mass ratio of isotactic polymethylmethacrylate changes with degrees of polymerization, tacticity, etc. of these polymers, it is desirable from points, such as the handling nature of a photo-setting resin constituent, that it is usually 1:10-10:1, and it is more desirable that it is 2:1. As for the content of the syndiotactic polymethylmethacrylate in a photo-setting resin constituent, and isotactic polymethylmethacrylate, it is desirable that it is more than 1 mass % to the mass of the whole photo-setting resin constituent, respectively, and it is more desirable that it is two to 30 mass %.

[0022] Especially by the living body model used for the purpose, such as medical-application simulation, the soft solid molding object which imitated not only the hard solid molding object that imitated the bone but a blood vessel, internal-organs tissue, etc. is called for in many cases. Therefore, when manufacturing a soft living body model by the 1st approach of this invention As a fluid accommodation component in a photo-setting resin constituent, for example, a butadiene, The elastomer which consists of the polymer or copolymers of conjugated diene, such as an isoprene and a chloroprene, The thermoplastic elastomer represented by the block copolymer which has a styrene system polymer block-(hydrogenation) diene system polymer block is used. It is good to prepare a photo-setting resin constituent to those elastomers combining what can show the property like [ a chain is comparatively long and ] a plasticizer among the above mentioned photopolymerization nature monomers or oligomer as a photoresist component, and to perform solid molding to them using it. In such a photo-setting resin constituent, the swelling degree of the elastomer particle by the photopolymerization nature monomer and/or oligomer changes with temperature, and a photo-setting resin constituent comes to produce sol-gel phase transition reversibly by the temperature change with it.

[0023] The photopolymerization initiator used with the photo-setting resin constituent used by the 1st approach of this invention Any are sufficient as long as it is the photopolymerization initiator of the

conventional known used as a photopolymerization initiator in the photopolymerization technique which uses ultraviolet rays and/or a visible ray. As an example A conventionally well-known benzophenone system compound, a benzoin alkyl ether system compound, A thioxan ton system compound, an anthraquinone system compound, a naphthoquinone system compound, a ketal system compound, alpha-diketone system compound, an acyl phosphine oxide system compound, etc. can be mentioned, and these one sort or two sorts or more can be used.

[0024] The photo-setting resin constituent used by the 1st approach of this invention may contain what is needlelike or fibrous like what spherical fine particles, such as globular form things, such as the detailed bulking agent which discovers thixotropy nature within limits which do not spoil the meaning of this invention if needed, for example, fumed silica, and colloidal silica, and silica gel, condensed, a tabular thing like a clay mineral, a whisker, or organic fiber. Furthermore, the photo-setting resin constituent used by the 1st approach of this invention may contain suitably other bulking agent, plasticizer, stabilizer, coloring agents, flame retarders, antioxidants, or antistatic agents within limits which do not spoil the meaning of this invention if needed.

[0025] By the 1st approach of this invention, two or more kinds of photo-setting resin constituents are used. As two or more kinds of photo-setting resin constituents used by the 1st approach of this invention It is based on the property required of the class of solid molding object finally manufactured, an application, and a solid molding object. In a solid molding object, for example, presentation; color tone; transparency;, for example, reinforcement, the rate of expanding, It is good to use what forms a mutually different part in at least one of chemical property, such as kinetic property and physical characteristics, such as an elastic modulus, a degree of hardness, flexibility, a compression property, thermal resistance, permeability, tractive characteristics, and cold resistance, and chemical resistance, weatherability, hydrolysis-proof nature, and a water resisting property. For example, what is necessary is just to use the combination of the photo-setting resin constituent containing a coloring agent, and the photo-setting resin constituent which does not contain a coloring agent, the combination of the photo-setting resin constituent containing a bulking agent, and the photo-setting resin constituent which forms a transparent photo-curing object, etc., when manufacturing the solid molding object which has the part where a color tone differs from transparency mutually. Moreover, what is necessary is just to use the combination of the photo-setting resin constituent which forms the photo-setting resin constituent which forms an elastic photo-curing object, and a hard photo-curing object etc., when manufacturing the solid molding object which has the part where degrees of hardness differ mutually. When manufacturing a living body model by the 1st approach of this invention, by choosing the combination of two or more kinds of photo-setting resin constituents by for example, the part equivalent to the affected parts, such as a gun organization, and the part equivalent to normal tissue By moreover, the part which is with the part equivalent to muscles, and the part equivalent to a blood vessel, and is further equivalent to muscles and the part equivalent to a bone If a photo-curing object is formed as it differs in a color tone, transparency, hardness, etc. mutually, a very useful precise living body model can be manufactured simply and quickly to education, an object for training, etc. of the simulation before an operation, and a medicine student.

[0026] In the 1st approach of this invention, in case the 1st layer is formed on a molding stage (molding table) Moreover, are in charge of forming one more layer on the resin layer which already carried out photo-curing. Especially the approach of supplying a photo-setting resin constituent on a molding stage or the resin layer which carried out photo-curing is not restricted. For example, two or more containers which hold each of two or more kinds of photo-setting resin constituents according to an individual, and may be made to discharge by the shape of a sol (tank), By the feeder equipped with the pressurization means for making a photo-setting resin constituent breathe out from a container, the control means of discharge

quantity or the amount of supply, and the applicator (X-Y plotter equipment) that has the location detection means of the direction of X-Y still more preferably The approach of extruding one kind of two or more kinds of photo-setting resin constituents or two kinds or more a constant rate every according to each slice configuration data for forming each class to the position on a molding stage or the resin layer which carried out photo-curing etc. is mentioned. Moreover, the distorted effect based on curing shrinkage may appear in the form of the distortion of a photo-curing resin layer (defect of smoothness) as the number of laminatings of the resin layer which carried out photo-curing increases and the thickness of a photo-curing object becomes thick. In this case, in order to avoid such a phenomenon, you may establish a level detection means to detect the smoothness of the resin layer which carried out photo-curing, and may also construct the program which adjusts and controls the discharge quantity from an applicator. Moreover, the supplied photo-setting resin constituent may be level sounded by RIKOTA as an option.

[0027] Moreover, in the 1st approach of this invention, the approach of printing a mask pattern on the layer which can adopt the approach of arbitration as an approach of giving a mask pattern, on the layer which consists of a photo-setting resin constituent, for example, consists of a photo-setting resin constituent using an ink jet means using light impermeability nature ink, the approach of arranging the bright films (PET film etc.) in which the mask pattern was formed, between a photo-setting resin constituent layer and the light source, etc. can be mentioned. Among those, but the approach of printing a mask pattern with an ink jet means using light impermeability nature ink is adopted preferably. Namely, the photo-setting resin constituent used by the 1st approach of this invention The layer which is the resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change, and was formed using this photo-setting resin constituent Since gel (the shape of a solid) is presented in case a mask pattern is given, even if it sprays light transmission nature ink on this layer and prints a mask pattern directly, a mask pattern does not collapse. When based on this approach, a desired mask pattern can be formed very good in a short time. In that case, the ink which melted one sort of ultraviolet ray absorbents, such as the ink and the benzophenone system which distributed carbon black, ferrous oxide, titanium oxide, and other detailed and opaque powder with the thickener in the water containing a surface active agent or a solvent, a benzotriazol system, a salicylic-acid system, and a hindered amine system, or two sorts or more to the thickener, the solvent, etc. can be mentioned as light impermeability nature ink used for formation of a mask pattern, for example.

[0028] In the 1st approach of this invention, what consists of a case which prevents the exsorption to the control means for controlling control, irradiation time, etc. of the lamp means by which a mercury-vapor lamp, a xenon lamp, a metal halide lamp, a halogen lamp, etc. are conventionally well-known, and optical system, the cooling means of a lamp means or a control means, and the exterior of light is preferably used as a light irradiation device for stiffening the layer which consists of a photo-setting resin constituent. As light may be irradiated on the whole top face of the photo-setting resin constituent given on the molding stage (laid) at homogeneity, you may be the turntable which may be equipped with two or more lamps, and a molding stage rotates. However, to take a turntable method, it is necessary to establish the positioning means of a firm table.

[0029] moreover, from the stereo-like photo-curing object which finished and generated all the required photo-curing processes in the 1st approach of this invention In removing the photo-setting resin constituent by which photo-curing was not carried out, and obtaining a solid molding object How to flush a non-hardened photo-setting resin constituent using the solvent with which a photo-curing object does not deteriorate, Which approaches, such as an approach of performing said approach while applying a supersonic wave, and the approach of making a non-hardened photo-setting resin constituent part the shape of a sol with heating, without using a solvent, and making it separate from a photo-curing (fluidizing) object,

may be adopted. Smeariness remains in the solid molding object obtained after separating a non-hardened photo-setting resin constituent part from a photo-curing object, when there is a possibility of soiling a hand etc., light may be irradiated again at a solid molding object, and hardening may be completed.

[0030] The solid molding object made into the purpose can be manufactured with simply and sufficient productivity with good dimensional accuracy, without using a support etc., even if a solid molding object is the thing of an overhang configuration when manufacturing a solid molding object by the 1st approach of this invention. From this point, the precise living body model which reproduced faithfully some living bodies or the gestalt of the whole body can be manufactured by the 1st approach of this invention. The living body model which distinguished the liver tissue invaded by the gun and normal liver tissue in color tone by the 1st approach of this invention can be manufactured. Although not limited, in order to manufacture such a living body model It responds to each tomography data (each slice configuration data of liver) obtained from a living body's liver part. For example, two or more kinds of photo-setting resin constituents with which a color tone and transparency differ from a presentation Each X-Y plotter equipment which has a nozzle according to individual is used. To the position on the stage for living body model manufacture Make it correspond to each of the liver tissue invaded by the gun and normal liver tissue, and it supplies separately. A mask pattern is given to parts which you want to harden, such as the unnecessary section or a border line, using an ink jet means to inject light impermeability nature ink etc. Perform an optical exposure from on this photo-setting resin constituent and a mask pattern, and the hardening resin layer corresponding to each slice configuration data of liver is made to form. The approach of removing the photo-setting resin constituent part which did not harden said actuation at the end repeatedly until the Mitsuzo form object equivalent to the whole liver was formed from a part for photo-curing Monobe etc. is adopted. The precise liver model by which a color tone and transparency differ from other physical properties can be manufactured by the part which the liver tissue invaded by the gun deserves by it, and the part equivalent to normal liver tissue.

[0031] Moreover, if it gives the part equivalent to the border line between different body tissues (boundary section), without using a mask pattern by the 1st approach of this invention only for formation of the rim equivalent part of a body tissue, the living body model which has a clearance can be formed in the boundary of the part which is equivalent to a different body tissue from the photo-setting resin constituent with which light was covered not hardening by the part. Moreover, the part equivalent to a living body's parenchyma is formed from elastic photo-curing resin, the part equivalent to a living body's hard organization is formed from hard photo-curing resin, and if a clearance is formed among both organizations by the above mentioned masking approach, the real living body model approximated by the living body can also be formed.

[0032] (II) 2nd approach [ of this invention ]:, next the 2nd approach of this invention are explained. Two or more kinds of the thermoplastic polymers or the thermoplastic polymer constituents which have preferably 60-250 degrees C of flow beginning temperature in the range of 80-180 degrees C are used for the 2nd approach of this invention. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. this -- one kind in two or more kinds of thermoplastic polymers, or a thermoplastic polymer constituent, or two kinds or more From the nozzle which it comes to attach in the X-Y plotter equipment according to individual prepared for every thermoplastic polymer or thermoplastic polymer constituent On a molding stage (molding table) in the state of a flow (melting condition) in Taira and others, respectively One layer While supplying by the shape of a field, cooling solidification is carried out immediately. Subsequently for example, on the layer which carried out cooling solidification Three-dimensions data by computer It slices in parallel. To the becoming following slice configuration data The thermoplastic polymer based and described above Or one kind in a thermoplastic polymer constituent, or two kinds or more While newly supplying Taira and others by one layer in the state of a flow (melting

condition), respectively from the nozzle which it comes to attach in the X-Y plotter equipment according to the above mentioned individual prepared for every thermoplastic polymer or thermoplastic polymer constituent, cooling solidification is carried out immediately. It is the approach of repeating said actuation two or more times, and manufacturing a solid molding object until the stereo-like solidification object equivalent to three-dimensions data is formed.

[0033] In forming said polymer layer for one layer, in the 2nd approach of this invention, it depends on the contents [ whether in order to form the polymer layer for this one layer, only one kind in a thermoplastic polymer or a thermoplastic polymer constituent is supplied, or two or more kinds are supplied ] of the slice configuration data used as the base at the time of forming this layer. when slice configuration data are the contents of data which consist of one homogeneity part on the whole (in for example, the case of the slice configuration data equivalent to n=p +1 in drawing 6 ), only one kind of thermoplastic polymer or a thermoplastic polymer constituent supplies -- having -- this -- one layer is formed. moreover, when slice configuration data are the contents of data which are heterogeneity mutually and which have two or more parts (in for example, the case of the slice configuration data equivalent to n=p +2 in drawing 6 ) it is this heterogeneity -- into a part two or more A corresponding number of two or more kinds of thermoplastic polymers or thermoplastic polymer constituents are separately supplied from each nozzle which it comes to attach in the X-Y plotter equipment according to individual, it is arranged in each location in one layer according to the contents of slice configuration data, and one layer is formed. Said one layer which supplied one kind or two kinds or more of thermoplastic polymers or thermoplastic polymer constituents, and was formed is cooled and solidified immediately below at the solidification temperature. especially -- this -- when one layer is formed from two or more kinds of thermoplastic polymers or thermoplastic polymer constituents, it is necessary to solidify promptly so that mixing may not arise between two or more thermoplastic polymers within one layer, or a thermoplastic polymer constituent

[0034] At a room temperature, if said thermoplastic polymer or the thermoplastic polymer constituent used by the 2nd approach of this invention presents the shape of a solid-state and is heated more than the flow beginning temperature (60-250 degrees C), it will flow. If the flow beginning temperature of a thermoplastic polymer or a thermoplastic polymer constituent is in within the limits which is 60-250 degrees C by the 2nd approach of this invention as two or more kinds of thermoplastic polymers or thermoplastic polymer constituents To the same thermoplastic polymer as the combination of two or more kinds of thermoplastic polymers, one thermoplastic polymer, and it from which a class differs, for example, a bulking agent, Combination with the thermoplastic polymer constituent which comes to add additives, such as a coloring agent, Although the same thermoplastic polymer is used as the base, any, such as combination of two or more kinds of thermoplastic polymer constituents with which presentations differ, and combination of two or more kinds of thermoplastic polymer constituents which use a mutually different thermoplastic polymer as the base, may be adopted. As the thermoplastic polymer which can be used by the 2nd approach of this invention, or a thermoplastic polymer constituent, the thermoplastic polymer constituent which uses one sort of the copolymers of a wax, polyethylene, polypropylene, an ethylene-vinylacetate copolymer, an ethylene methyl methacrylate copolymer, transformer polyisoprene, the poly caprolactone, methyl methacrylate, and other alkyl (meta) acrylate or these polymers or two sorts or more as the base is mentioned, for example. Among these, since a wax is easily removable from a body part by performing hot water washing and steam washing by the final process of the production process of a solid molding object In case a solid molding object is manufactured according to the 2nd approach of this invention using other thermoplastic polymers and/or ********** polymer constituents A thermoplastic polymer and/or a thermoplastic polymer constituent can overflow into the method of outside too much the profile of the solid molding object made into the purpose, and it can be used also as a separation means (auxiliary material) not

to lose the configuration precision of a solid molding object. Moreover, by the 2nd approach of this invention, according to the configuration of a solid molding object etc., it may function as a support during solid molding, and after termination of solid molding may perform solid molding using the thermoplastic polymer or the thermoplastic polymer constituent removed from a solid molding object with two or more kinds of the thermoplastic polymers or the thermoplastic polymer constituents which constitute a solid molding object. The thermoplastic polymer or the thermoplastic polymer constituent used by the 2nd approach of this invention may contain one sort, such as a bulking agent, a plasticizer, a stabilizer, a coloring agent, a flame retarder, an antioxidant, and an antistatic agent, or two sorts or more within limits which do not spoil the meaning of this invention if needed.

[0035] By the 2nd approach of this invention, as two or more kinds of thermoplastic polymers or thermoplastic polymer constituents It is based on the property required of the class of solid molding object finally manufactured, an application, and a solid molding object. In a solid molding object, for example, presentation; color tone; transparency;, for example, reinforcement, the rate of expanding, What forms a mutually different part in at least one of chemical property, such as kinetic property and physical characteristics, such as an elastic modulus, a degree of hardness, flexibility, a compression property, thermal resistance, permeability, tractive characteristics, and cold resistance, and chemical resistance, weatherability, hydrolysis-proof nature, and a water resisting property, is used. For example, what is necessary is just to use the combination of the thermoplastic polymer constituent containing a coloring agent, and the thermoplastic polymer which does not contain a coloring agent, combination with the thermoplastic polymer which forms the thermoplastic polymer constituent containing a bulking agent, and a transparent photo-curing object, etc., when manufacturing the solid molding object which has the part where a color tone differs from transparency mutually. Moreover, what is necessary is just to use the combination of a supple thermoplastic polymer, a thermoplastic polymer constituent and a hard thermoplastic polymer, or a thermoplastic polymer constituent etc., when manufacturing the solid molding object which has the part where degrees of hardness differ mutually. As well as the case of the 1st approach of this invention when manufacturing a living body model by the 2nd approach of this invention, by choosing the combination of two or more kinds of thermoplastic polymers, or a thermoplastic polymer constituent By for example, the part equivalent to the affected parts, such as a gun organization, and the part equivalent to normal tissue By the part which is with the part equivalent to muscles, and the part equivalent to a blood vessel, or is equivalent to muscles, and the part equivalent to a bone A mutually different precise living body model in a color tone, transparency, hardness, etc. which is useful to education, an object for training, etc. of the simulation before an operation and a medicine student can be manufactured simply and quickly.

[0036] As an approach of supplying the melt of a thermoplastic polymer or a thermoplastic polymer constituent, and forming the polymer layer for one layer on a molding stage (molding table), in the 2nd approach of this invention For example, the container which comes to fill up a thermoplastic polymer or a thermoplastic polymer constituent (tank), A means to heat a thermoplastic polymer or a thermoplastic polymer constituent more than flow beginning temperature, RETA is used. the application equipped with a means to control the means which carries out the quantum of the discharge quantity from the nozzle of the fused thermoplastic polymer or a thermoplastic polymer constituent, the location detection means in the direction of X-Y of a nozzle, and them -- After extruding the melt of a thermoplastic polymer or a thermoplastic polymer constituent from this applicator a constant rate every to the position on a stage, the approach of spraying on the part which leads the flow of Ayr generated with a fan's etc. means to thin passage, and requires cooling, and solidifying is mentioned. When the projection has arisen on the front face of the layer of the thermoplastic polymer supplied on the molding table or the already solidified polymer layer, or a thermoplastic polymer constituent and it has not become a smooth field, in order to obtain the

solid molding object which is excellent in dimensional accuracy, the means for carrying out flattening of the front face of the layer of the melt of a thermoplastic polymer or a thermoplastic polymer constituent may be established. Although the distorted effect based on contraction of a thermoplastic polymer or a thermoplastic polymer constituent may appear in the form of lack of the surface smoothness in a solid molding object as the number of laminatings of the layer of the solidified thermoplastic polymer or a thermoplastic polymer constituent increases and the thickness of a solidification object becomes thick If required, a level detection means to detect the surface smoothness of the solidified polymer layer can be established, and the program which adjusts and controls the discharge quantity from an applicator can also be constructed.

[0037] The 3rd approach of this invention : (III) The 3rd approach of this invention One or more kinds of the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change combining the 1st above mentioned approach of this invention and the 2nd above mentioned approach of this invention, One or more kinds of the thermoplastic polymer in the range whose flow beginning temperature is 60-250 degrees C, or a thermoplastic polymer constituent are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. One kind in the above mentioned photo-setting resin constituent, a thermoplastic polymer, and a thermoplastic polymer constituent, or two kinds or more in the state of the shape of a sol, and a flow While supplying by one layer on a molding stage (molding table) in Taira and others above the area which said slice configuration data occupy, it is made to gel and/or solidify immediately. After giving a mask pattern to the part in this layer which carries out photo-curing, Irradiate light and photo-curing of the photo-setting resin constituent part where the mask pattern is not given is carried out. Subsequently, on said layer including the part which carried out photo-curing Three-dimensions data by computer the following slice configuration data which it comes to slice in parallel -- being based -- one kind in said photo-setting resin constituent carried out and thermoplastic polymer, or a thermoplastic polymer constituent -- or, while newly supplying two or more kinds to Taira and others by one layer in the state of the shape of a sol, and a flow After making it gel and/or solidify immediately and giving a mask pattern to the part in this layer which carries out photo-curing, irradiate light and a layer including the part which was made to carry out photo-curing of the photo-setting resin constituent part where the mask pattern is not given, and carried out photo-curing is made to form. It is the approach of removing a multiple-times repeat and the photo-setting resin constituent by which photo-curing subsequently was not carried out from a stereo-like object for said actuation, and manufacturing a solid molding object until the stereo-like object equivalent to three-dimensions data is formed.

[0038] By the 3rd approach of this invention, the same thing as the thermoplastic polymer or the thermoplastic polymer constituent used by the photo-setting resin constituent and the 2nd approach of this invention which are used by the 1st approach of this invention as a photo-setting resin constituent, a thermoplastic polymer, or a thermoplastic polymer constituent can be used. By the 3rd approach of this invention, since it is a thing using a photo-setting resin constituent, a thermoplastic polymer or the resin of varieties called a thermoplastic polymer constituent and a polymer, and a polymer constituent, combination very various as two or more sorts of those combination is possible, and a more precise solid molding object can be formed at this point according to the application of a solid molding object etc. By the 3rd approach of this invention, the same approach and equipment as the 1st approach of this invention and/or the 2nd approach of this invention are adopted also in the separation approach of the photo-setting resin constituent which is not carrying out photo-curing from the formation approach of a mask pattern, photo-curing and/or the formation approach of a layer which carried out cooling solidification or formation equipment, and the solid molding object in a final process etc.

[0039] When it is in charge of adopting the 3rd approach of this invention and manufacturing a living body

model, for example, a living body's profile section (body surface section) is previously manufactured with a thermoplastic polymer or a thermoplastic polymer constituent, it becomes Tsutsumi for the profile section which consists of a thermoplastic polymer or a thermoplastic polymer constituent to hold a photo-setting resin constituent into a part in the living body, and there is an advantage it becomes unnecessary to supply an expensive photo-setting resin constituent too much. Moreover, if it programs to supply a thermoplastic polymer or a thermoplastic polymer constituent, and a photo-setting resin constituent by turns in case the living body model reproducing two or more tissues in the living body is manufactured by the 3rd approach of this invention A trouble with which the part where each organization deserves [ in / for pasting up mutually / a living body model ] a thermoplastic polymer or a thermoplastic polymer constituent, and a photo-setting resin constituent using **** stops sticking and separating is avoidable.

[0040]

[Example] Although an example explains this invention concretely below, this invention is not limited to an example. The contents of the photo-setting resin constituent used in the following examples 1-3 and/or a thermoplastic polymer (thermoplastic polymer constituent) are shown in the following Table 1 and 2.

[0041]

[Table 1]

[0042]

[Table 2]

[0043] In addition, the monomer indicated to the above-mentioned Table 1 and 2, or the cable address and the contents of a polymer are as follows.

- An MMA:methyl-methacrylate monomer and PMMA : polymethyl methacrylate (Kuraray Make: parapet LW- 1000, syndiotactic comparatively 65%)
- i-PMMA : isotactic-polymethyl methacrylate (what was manufactured according to anionic polymerization, using t-butyl magnesium star's picture as an initiator; isotactic comparatively 90%)
- 2EHA : A 2-ethylhexyl-acrylate monomer and a red color: "#310" by Kioritz chemistry incorporated company
- PE:polyethylene ("nova tech HJ-290" by Japan Polychem, Inc.), and white pigments : titanium oxide ("TIPAQUE" by Ishihara Sangyo Kaisha, Ltd.)

**IR: Polyisoprene rubber ("IR-10" By Kuraray)

- Oil : process oil ("PW-380" by Idemitsu petrochemical incorporated company)

[0044] <<example 1>> Manufacture] of a liver model which has [lesion section

(1) In this example 1, the liver model equivalent to the liver which has the lesion section equivalent to drawing 1 was manufactured according to the 1st approach of this invention, using the photo-setting resin constituent C (elasticity red) as an object for parts equivalent to the lesion section, using the photo-setting resin constituent B (elasticity transparence) as two kinds of photo-setting resin constituents, and an object for parts which is specifically equivalent to the normal section. Namely, two nozzles combined with the X-Y plotter equipment according to individual which can apply a photo-setting resin constituent on the molding stage (molding table) which was connected with two resin tanks and the resin tank of these two individuals which have a heating means, and which can be moved up and down, And the equipment which is equipped with the ink jet head combined with the X-Y plotter equipment which can print ultraviolet-rays protection-from-light nature ink as a main mechanical component, and is equipped with an ultraviolet ray

lamp as the light source is used. According to the procedure shown in drawing 3 - drawing 5 , the model of the liver shown with the schematic diagram of drawing 1 which has a part equivalent to the lesion section in the part equivalent to the normal section was manufactured.

[0045] (2) After changing into an STL format a patient's liver data which have the lesion section shown in the schematic diagram of drawing 1 obtained by CAT by computer, as further shown in drawing 2 , it sliced by computer and asked for the slice configuration data (slice cross-section data) of each class.

(3) In drawing 2 , the slice cross-section data which do not contain the lesion section are from the 1st layer of n= 1 to the layer of n=p. The photo-setting resin constituent B was independently used for the Mitsuzo form for these layers, and it performed it by the approach shown in the schematic diagram of drawing 3 . Namely,

(i) Process which carries out heating fusion of the photo-setting resin constituent B at 120 degrees C, makes it the shape of a sol (liquefied), supplies by one layer on the molding stage 3 from a nozzle 1, makes it gel with air cooling immediately, and forms a flozen layer (solidifying) 4-1 (** of drawing 3 );

(ii) Process which forms the protection-from-light nature mask pattern 6-1 by the ink jet head 5 on the flozen layer 4-1 formed above based on slice cross-section data (** of drawing 3 );

(iii) Process which forms the resin section 8-1 which performed the field exposure and carried out photo-curing into the layer with the black light 7 (** of drawing 3 );

(iv) After dropping the molding stage 3 by one layer, the resin section 8-1 which was formed with the above (iii) and which carried out photo-curing on the field of the layer (n= 1) included in a layer Process which supplies by one layer, carries out air cooling of the photo-setting resin constituent B heated and fused at 120 degrees C immediately, gels it from a nozzle 1, and forms a flozen layer (solidifying) 4-2 (** of drawing 3 );

(v) Process; repeated until the layer of n=p is formed in the process of said (ii) - (iv) based on each slice cross-section data to the flozen layer 4-2 generated above was adopted, and the Mitsuzo form of the part which corresponds by the layer of n=p was performed from the 1st layer of n= 1.

[0046] (4) In drawing 2 , the slice cross-section data containing the lesion section are to the layer of n=p +1 to n=q. Then, following the Mitsuzo form of the above (3), both the photo-setting resin constituent B and the photo-setting resin constituent C were used, and the Mitsuzo form to the layer of n=p +1 to n=q was performed by the approach shown in the schematic diagram of drawing 4 . Namely, (i) It supplies on the layer (layer equivalent to n=p) containing the resin section which carried out heating fusion, made the photo-setting resin constituent B in each tank, and the photo-setting resin constituent C the shape of a sol (liquefied), and carried out photo-curing to 120 degrees C by one layer from the nozzle 1 and the nozzle 2, respectively. It is immediately made gel with air cooling (solidifying). The part which consists of a photo-setting resin constituent B The process in which the part which consists of a photo-setting resin constituent C forms flozen layer 4-p1 distributed in one layer (**' of drawing 4 ); (ii) Protection-from-light nature mask pattern 6-p1 by the ink jet head 5 based on slice cross-section data on flozen layer 4-p1 generated above Process to form (**' of drawing 4 );

(iii) Process which carries out a field exposure with a black light 7, and forms resin section 8-p1 which carried out photo-curing (**' of drawing 4 );

(iv) After dropping the molding stage 3 by one layer, photo-curing resin section 8-p1 formed with the above (iii) on the field of the layer (layer equivalent to n=p +1) included in a layer Supply the photo-setting resin constituent B and the photo-setting resin constituent C which were heated and fused at 120 degrees C by one layer through a nozzle 1 and a nozzle 2, and it is immediately made gel with air cooling (solidifying). Process which forms flozen layer 4-p2 from which the photo-setting resin constituent B section and the photo-setting resin constituent C section were distributed in one layer (**' of drawing 4 );

(v) Process; repeated until the layer of n=q forms the process of said (ii) - (iv) based on slice cross-section data to flozen layer 4-p2 generated above respectively was adopted, and the Mitsuzo form of the part (part which

has a part equivalent to the lesion section) to the layer of n=p +1 to n=q was performed.

[0047] (5) Since the molding object with which the molding section 9 which consists of resin which carried out photo-curing with the photo-setting resin constituent 10 which is not carrying out photo-curing was surrounded mostly was acquired as the above-mentioned process showed to (a) of drawing 5 By heating it for 5 minutes at 120 degrees C, fusing the part of the non-hardened photo-setting resin constituent 10, and dissociating from the molding (making it shape of sol) object 9, the liver model which is shown in (b) of drawing 5 and which has a part equivalent to the lesion section was obtained. Adhesion between the part which is equivalent to the lesion section since the part which the part which is equivalent to the lesion section by this liver model is elasticity red, and the part equivalent to the normal section is elasticity transparence, and both parts have living body liver and a similar elastic modulus, and is moreover further equivalent to the lesion section, and the part equivalent to the normal section are formed from the homogeneous photo-setting resin constituent, although color tones differ, and the part equivalent to the normal section was good. And since the condition of the part equivalent to the lesion section was easily checked from the outside by this liver model, it was very useful in the simulation before an operation, a medicine student's education, etc.

[0048] <<example 2>> Manufacture] of a liver model which has [lesion section

(1) The liver model [the liver model shown in (b) of drawing 5 ] equivalent to the liver which has the lesion section equivalent to drawing 1 in this example 2 One kind of thermoplastic polymer, two kinds of thermoplastic polymer constituents, and a (for a support; hard translucence), b (for [ equivalent to the normal section ] parts; rubber-like transparence) and c (for [ equivalent to the lesion section ] parts; rubber-like red) in Table 2 were specifically used, and it manufactured according to the 2nd approach of this invention. The liver model shown in drawing 5 was manufactured by manufacturing the solid molding object of the configuration shown in drawing 8 in consideration of a support part in that case, and separating the support section. Namely, three nozzles combined with the X-Y plotter equipment according to individual which can apply a thermoplastic polymer or a thermoplastic polymerization body composition object on the molding stage (molding table) which was connected with three polymer tanks and the polymer tank of these three individuals which have a heating means, and which can be moved up and down, And the procedure which shows a cooling system in drawing 7 using the equipment which it has as a main mechanical component is followed. After manufacturing the solid molding object with a support shown with the schematic diagram of drawing 8 which has a part equivalent to the lesion section in the part equivalent to the normal section, and has the support section, the liver model shown in drawing 5 was manufactured by separating the support section from this solid molding object.

[0049] (2) After changing into an STL format a patient's liver data which have the lesion section shown in the schematic diagram of drawing 1 obtained by CAT by computer, as further shown in drawing 6 , it sliced by computer and asked for the slice configuration data (slice cross-section data) of each class. In drawing 6 , the slice cross-section data which contain the support section and the normal section excluding the lesion section are from the 1st layer of n= 1 to the layer of n=p. The thermoplastic polymer a (for the support sections) and the thermoplastic polymer constituent c (for the normal sections) photo-setting resin constituent were used for the Mitsuzo form for these layers, and it performed them by the approach shown in this schematic drawing of drawing 7 . Namely, (i) Based on the 1st slice cross-section data, carry out heating fusion, make the thermoplastic polymer a into the letter of a flow, and it is supplied on the molding stage 3 through a nozzle 11 at 110 degrees C. At 190 degrees C, carry out heating fusion, make the thermoplastic polymer constituent b into the letter of a flow, and it is supplied on the molding stage 3 through a nozzle 12 at coincidence. Process which is immediately cooled and solidified with a cooling system and forms the 1st flozen layer 14-1 over which the part which consists of a thermoplastic polymer a, and the

part which consists of a thermoplastic polymer constituent b are distributed in one layer (** of drawing 7 );
(ii) After dropping the molding stage 3 by one layer, on the field of the flozen layer 14-1 (layer equivalent to n= 1) formed with the above (i) Based on the 2nd slice cross-section data, carry out heating fusion, make the thermoplastic polymer a into the letter of a flow, and it is supplied to 110 degrees C through a nozzle 11. Carry out heating fusion, make the thermoplastic polymer constituent b into the letter of a flow, and it is supplied to 190 degrees C through a nozzle 12 at coincidence. Process which is immediately cooled and solidified with a cooling system and forms the 2nd flozen layer 14-2 over which the part which consists of a thermoplastic polymer a, and the part which consists of a thermoplastic polymer constituent b are distributed in one layer (** of drawing 7 );
(iii) Process; repeated until the layer of n=p is formed in the process of the above (ii) based on each slice cross-section data to the flozen layer 14-2 generated above was adopted, and the part which corresponds by the layer of n=p was molded from the 1st layer of n= 1.
[0050] (3) After dropping the molding stage 3 by one layer, next, on flozen layer 14-p (flozen layer equivalent to n=p) formed with the above (2) Based on slice cross-section data, heating fusion was carried out, and the thermoplastic polymer constituent b was made into the letter of a flow, was supplied to 190 degrees C from the nozzle 12, and was immediately cooled and solidified with the cooling system, and the flozen layer (flozen layer equivalent to n=p +1) which consists of a thermoplastic polymer constituent b was formed (** of drawing 7 ).
(4) (i) Then, after dropping the molding stage 3 by one layer, On the flozen layer (flozen layer equivalent to n=p +1) formed above (4) Based on slice cross-section data, carry out heating fusion, make the thermoplastic polymer constituent b (for [ equivalent to the normal section ] parts; transparence) into the letter of a flow, and it is supplied to 190 degrees C through a nozzle 12. Carry out heating fusion, make the thermoplastic polymer constituent c (for [ equivalent to the lesion section ] parts; red) into the letter of a flow, and it is supplied to 190 degrees C through a nozzle 13 at coincidence. It was made to cool and solidify with a cooling system immediately, and the flozen layer (flozen layer equivalent to n=p +2) from which the part which consists of a thermoplastic polymer constituent b, and the part which consists of a thermoplastic polymer constituent c are distributed in one layer was formed.
(ii) The process repeated until the layer of n=q is formed in the same process as the above (i) based on each slice cross-section data to the flozen layer generated above (i) was adopted, and the solid molding object which has the part 17 equivalent to the part 16 and the lesion section equivalent to the support section 15 as shown in drawing 8 , and the normal section was manufactured.
[0051] (5) By heating the solid molding object of drawing 8 obtained above (5) at 110 degrees C, only the support section 15 carried out melting liquefaction, it dissociated from the body section which consists of a part 16 and a part 17 easily, and the liver model which is shown in (b) of drawing 5 and which has a part equivalent to the lesion section was obtained. The part which is equivalent to the lesion section by this liver model is red, and the part equivalent to the normal section is transparent and colorless. And although color tones differ, since the part which both parts have living body liver and a similar elastic modulus, and is further equivalent to the lesion section, and the part equivalent to the normal section are formed from the homogeneous thermoplastic polymer constituent, Adhesion between the part equivalent to the lesion section and the part equivalent to the normal section was good, and since the condition of the part equivalent to the lesion section was easily checked from the outside, it was very useful in the simulation before an operation, a medicine student's education, etc.
[0052] <<example 3>> ([manufacture of the living body model which has a muscular equivalent part and a bone equivalent part] 1) In this example 3 The photo-setting resin constituent A (shape of the skull; for [ this ] parts hard transparence), the photo-setting resin constituent C (for muscular equivalent parts; **

type red), and three kinds of polymers of the thermoplastic polymer a (; for the space section equivalent parts between a bone and muscles -- hard -- translucent) are used. The living body model which has the muscular equivalent part and bone equivalent part equivalent to drawing 9 according to the 3rd approach of this invention, and has space between a muscular equivalent part and a bone equivalent part was manufactured. namely, [ which can apply a photo-setting resin constituent and a thermoplastic polymer on three resin (polymer) tanks by which it has a heating means, and the molding stage (molding table) which can be moved up and down ] Three nozzles combined with the X-Y plotter equipment according to individual connected with said three tanks, At the process shown after following (2) using the equipment which is equipped with the ink jet head and cooling system which were combined with the X-Y plotter equipment which can print ultraviolet-rays protection-from-light nature ink as a main mechanical component, and is equipped with an ultraviolet ray lamp as the light source The living body model which has a muscular equivalent part equivalent to drawing 9 and a bone equivalent part was manufactured.

[0053] (2) After changing into an STL format the living body section data obtained by CAT by computer, as further shown in drawing 10 , it sliced by computer and asked for the slice configuration data (slice cross-section data) of each class.

(3) Based on the slice cross-section data obtained above (2), molding in the layer (layer equivalent to the slice cross-section data of n= 1 - n=p in drawing 10 ) which has only the part which is equivalent to muscles in one layer was performed by adopting the process same in (3) of an example 1 using the photo-setting resin constituent C.

(4) Next, molding in the layer (layer equivalent to the slice cross-section data of n=p +1 in drawing 10 - n=q) which has a part equivalent to the part which is equivalent to muscles in one layer, the part equivalent to space, and a bone was performed by adopting the process same in (4) of an example 1 using the photo-setting resin constituent A, the photo-setting resin constituent C, and the thermoplastic polymer a.

(5) Then, molding in the layer (layer equivalent to the slice cross-section data of n=q +1 in drawing 10 - n=r) which has the part which is equivalent to a bone in one layer, and a part equivalent to space was performed by adopting the process same in (4) of an example 1 using the photo-setting resin constituent A and the thermoplastic polymer a.

[0054] (6) Next, molding in the layer (layer equivalent to the slice cross-section data after n=r +1 in drawing 10 ) which has only a part equivalent to a bone in one layer was performed by adopting the process same in (3) of an example 1 using the photo-setting resin constituent A.

(7) Since the molding object with which the molding section which consists of resin which carried out photo-curing with the photo-setting resin constituent 10 which is not carrying out photo-curing, and a solidified thermoplastic polymer was surrounded mostly was acquired as the above-mentioned process showed to drawing 11 By heating it for 5 minutes at 120 degrees C, fusing the thermoplastic polymer a equivalent to non-hardened the part and the space section of the photo-setting resin constituent 10, and dissociating from a molding object The living body model which has the muscular equivalent part and bone equivalent part equivalent to drawing 9 , and has space between a muscular equivalent part and a bone equivalent part was manufactured. By this living body model, a muscular equivalent part is elasticity red, a bone equivalent part is hard transparence, and since space moreover exists between a muscular equivalent part and a bone equivalent part similarly in a living body, it can know the actual organization in a living body easily and certainly.

[0055]

[Effect of the Invention] When based on this invention, two or more parts where a color tone, transparency, kinetic property, and a physical characteristic differ from chemical property etc. in one solid molding object are formed complexly, and can manufacture the precise solid molding object which can be used effective in

the industrial field, the medical field, and various applications, such as the field, with sufficient productivity in a quick and high molding precision. Especially the approach of this invention is suitable for manufacture of a living body model. For example Only the specific affected part reproduced living body model; -- living body model;, such as a torso image and ****, -- the lesion part which is the living body model which reproduced the gestalt of an affected part organization faithfully, and should be excised with the normal part of an in-house -- mutual -- an identifiable color tone etc. -- production living body model; -- the living body which consists of transparent resin a whole body model or living body model [ of the format that the affected part organization of a different color tone from other parts in a section model is buried ]; -- the inside of the whole body model of the living body which consists of transparent resin, or a section model -- a medical practitioner -- an endoscope -- the affected part -- going -- it is going to insert -- two or more organizations which an endoscope may approach or contact in the case -- And a living body model by which the target affected part is mutually created by the resin of a color tone with other identifiable parts; various precise living body models, such as a living body model which reproduced more faithfully the affected part organization which consists of two or more resin which has dynamics properties, such as an elastic modulus modeled on the body tissue, or a polymer It can manufacture quickly and easily. Therefore, the living body model obtained by the approach of this invention is very useful as the object for practice of a medical practitioner before an operation (for simulation), the object for image training, education, an object for training of a medicine student or the student nurse, etc. And when based on the 1st approach of this invention, the support of another object which complicates the Mitsuzo form process, support attachment in a solid molding object, etc. are unnecessary, and can manufacture easily various kinds of above mentioned solid molding objects made into the purpose.

---

## TECHNICAL FIELD

---

[Field of the Invention] This invention relates to the solid molding object obtained by that cause by the approach the part which consists of the part and/or each thermoplastic polymer which consist of each resin constituent manufactures quickly the solid molding object compound-ized in three dimensions in one solid molding object to a precision, and the list using two or more kinds of photo-setting resin constituents and/or thermoplastic polymers (thermoplastic polymer constituent). Especially the approach of this invention is useful as a manufacturing method of a living body model, and the solid molding object obtained by this invention, especially a living body model can be used from reproducing a living body's condition correctly effective in the applications for the medical simulation for the check before an operation by education and training of a medicine student, and the medical practitioner, or practice etc., for example.

---

## PRIOR ART

---

[Description of the Prior Art] Conventionally, the living body model used for the medical-application simulation a check before an operation, for practice, etc. by education and training of a medicine student, and the medical practitioner belonged to the mannequin with the inorganic most. Moreover, it is produced using the elasticity elastomer and the elastic doll which has the internal structure which is equivalent to a trachea, lungs, or the heart depending on the case, a tube containing simulation blood, etc. is used for

training of lifesaving revival, practice of an intravenous injection, etc. in recent years. However, no they are what does not come out of the region of the uniform mannequin made based on the data of typical anatomy, and reproduced faithfully each focus situation peculiar to a patient and living body gestalt. Therefore, although it was helpful to practice of a medical aid procedure, for [ the check before an operation by the medical practitioner, for practice, etc. ] medical-application simulation, it was not fully utility.

[0003] Moreover, since there are few damages given to a patient as compared with the usual surgical operation in recent years, the method of operation using an endoscope progresses and it is in the limelight. Although undergoing an operation, photoing the affected part and looking at the image in an endoscopic operation is also performed, since it is not that on which unlike a surgical operation an operation is performed while viewing the affected part directly, high skill level is required. Then, although request of wanting SHIMYURESHONSHI several times is strong before actually performing an endoscopic operation, the actual condition is not realized from there being no living body model which reproduced each patient's affected part situation faithfully.

[0004] The Mitsuzo form approach which forms a molding object on the other hand by repeating actuation of irradiating light and stiffening it after drawing a mask pattern to the part which gives at a time one layer of one kind of photo-setting resin constituent which causes sol-gel phase transition in the international public presentation WO 01/No. 10632 official report reversibly and quickly by physical changes, such as temperature, in the shape of a layer, and carries out photo-curing is indicated. Although a Mitsuzo form object can be quickly manufactured, without arranging a support when based on this approach Since the Mitsuzo form is performed using one kind of photo-setting resin constituent For example, the part equivalent to the affected part and the part equivalent to normal tissue cannot manufacture the highly efficient living body model which it is formed possible [ distinction ] into one solid molding object, it is compound-ized, and can be used effective in the simulation in the medical field etc. and applying that optical solid molding method to production of general industrial use articles, such as a gearing, is only indicated by this official report, and it applies to production of a living body model -- it is not indicated even things.

[0005] Moreover, although the optical solid molding method for manufacturing a solid molding object not only using the approach indicated by the above-mentioned international public presentation official report but using a photo-setting resin constituent is variously learned also from the former Since molding is performed only using one kind of photo-setting resin constituent also in the conventional optical solid molding method, it cannot fully apply that the distinguishable part is mutually formed complexly into one solid molding object to manufacture of the living body model currently called for strongly. Furthermore, although the solid molding object with which two or more parts where a color tone and kinetic property differ from a physical characteristic etc. are complexly formed into one molding object also not only in a living body model but in the Mitsuzo form object used as an industrial components model etc. may be required It was difficult to manufacture such a molding object by the conventional optical solid molding method for performing optical solid molding only using one kind of photo-setting resin constituent.

---

---

EFFECT OF THE INVENTION

---

[Effect of the Invention] When based on this invention, two or more parts where a color tone, transparency, kinetic property, and a physical characteristic differ from chemical property etc. in one solid molding object are formed complexly, and can manufacture the precise solid molding object which can be used effective in

the industrial field, the medical field, and various applications, such as the field, with sufficient productivity in a quick and high molding precision. Especially the approach of this invention is suitable for manufacture of a living body model. For example Only the specific affected part reproduced living body model; -- living body model;, such as a torso image and ****, -- the lesion part which is the living body model which reproduced the gestalt of an affected part organization faithfully, and should be excised with the normal part of an in-house -- mutual -- an identifiable color tone etc. -- production living body model; -- the living body which consists of transparent resin a whole body model or living body model [ of the format that the affected part organization of a different color tone from other parts in a section model is buried ]; -- the inside of the whole body model of the living body which consists of transparent resin, or a section model -- a medical practitioner -- an endoscope -- the affected part -- going -- it is going to insert -- two or more organizations which an endoscope may approach or contact in the case -- And a living body model by which the target affected part is mutually created by the resin of a color tone with other identifiable parts; various precise living body models, such as a living body model which reproduced more faithfully the affected part organization which consists of two or more resin which has dynamics properties, such as an elastic modulus modeled on the body tissue, or a polymer It can manufacture quickly and easily. Therefore, the living body model obtained by the approach of this invention is very useful as the object for practice of a medical practitioner before an operation (for simulation), the object for image training, education, an object for training of a medicine student or the student nurse, etc. And when based on the 1st approach of this invention, the support of another object which complicates the Mitsuzo form process, support attachment in a solid molding object, etc. are unnecessary, and can manufacture easily various kinds of above mentioned solid molding objects made into the purpose.

---

TECHNICAL PROBLEM

---

[Problem(s) to be Solved by the Invention] The purpose of this invention is offering the solid molding method for the ability manufacturing the solid molding object with which two or more parts where a color tone, transparency, kinetic property, and a physical characteristic differ from chemical property etc. are complexly formed into one solid molding object in a quick and high molding precision. Especially this invention sets it as the important purpose to offer the solid molding method for the ability to manufacture the living body model of the condition more near the living body of thing with sufficient productivity as a living body model used for a medicine student's practice teaching, training, medical-application simulation, etc. And the purpose of this invention is offering the living body model and the other solid molding objects with which two or more parts where a color tone, transparency, kinetic property, and a physical characteristic differ from chemical property etc. are formed precisely and complexly into one solid molding object.

---

---

MEANS

---

[Means for Solving the Problem] [ whether this invention persons perform two or more kinds of specific optical solid molding methods using the photo-setting resin constituent which causes sol-gel phase transition

reversibly and quickly by the temperature change, as a result of inquiring wholeheartedly, in order to solve the above-mentioned technical problem, and ] [ whether solid molding is performed by the specific approach using two or more kinds of the thermoplastic polymers or the thermoplastic polymer constituents in the range whose flow beginning temperature is 60-250 degrees C, and ] When solid molding is performed by the specific approach using one or more kinds of the thermoplastic polymer in within the limits whose one or more kinds and flow beginning temperature of the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change are 60-250 degrees C, or a thermoplastic polymer constituent, or a color tone, Two or more different parts, such as transparency, kinetic property, a physical characteristic, and chemical property, can manufacture the solid molding object currently complexly formed into one molding object in a quick and high molding precision, And especially these solid molding methods found out that it was effective as the manufacture approach of a living body model, and completed this invention.

[0008] Namely, this invention (1) Two or more kinds of photo-setting resin constituents which cause sol-gel phase transition reversibly and quickly by the temperature change are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. this -- 1 of two or more kinds of photo-setting resin constituents, or two kinds or more While supplying Taira and others by one layer above the area which said slice configuration data occupy by the shape of a sol, cooling gelation is carried out immediately. After giving a mask pattern to the part in this photo-setting resin constituent layer which carries out photo-curing, On said resin layer including the part which was made to carry out photo-curing of the part where light is irradiated and the mask pattern is not given, and subsequently carried out photo-curing Or while newly supplying two or more kinds to Taira and others by one layer by the shape of a sol, cooling gelation is carried out immediately. the following slice configuration data which come to slice three-dimensions data by computer in parallel -- being based -- one kind in said photo-setting resin constituent carried out -- After giving a mask pattern to the part in this photo-setting resin constituent layer which carries out photo-curing, irradiate light and a resin layer including the part which was made to carry out photo-curing of the part where the mask pattern is not given, and carried out photo-curing is made to form. It is the manufacture approach (it may be called below "the 1st approach of this invention") of the solid molding object characterized by removing a multiple-times repeat and the photo-setting resin constituent by which photo-curing subsequently was not carried out from a stereo-like photo-curing object for said actuation until the stereo-like photo-curing object equivalent to three-dimensions data is formed.

[0009] And this invention (2) Two or more kinds of the thermoplastic polymers or the thermoplastic polymer constituents in the range whose flow beginning temperature is 60-250 degrees C are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. this -- one kind in two or more kinds of thermoplastic polymers, or a thermoplastic polymer constituent, or two kinds or more While supplying Taira and others by one layer in the state of a flow from the nozzle which it comes to prepare in the X-Y plotter equipment according to individual, cooling solidification is carried out immediately. Subsequently, on this layer that carried out cooling solidification Or while newly supplying two or more kinds to Taira and others by one layer in the state of a flow, cooling solidification is carried out immediately. the following slice configuration data which come to slice three-dimensions data by computer in parallel -- being based -- one kind in said thermoplastic polymer carried out or a thermoplastic polymer constituent -- It is the manufacture approach (it may be called below "the 2nd approach of this invention") of the solid molding object characterized by repeating said actuation two or more times until the stereo-like solidification object equivalent to three-dimensions data is formed.

[0010] Furthermore, this invention (3) One or more kinds of the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change, One or more kinds of the

thermoplastic polymer in the range whose flow beginning temperature is 60-250 degrees C, or a thermoplastic polymer constituent are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. While supplying one kind in the above mentioned photo-setting resin constituent, a thermoplastic polymer, and a thermoplastic polymer constituent, or two kinds or more to Taira and others by one layer above the area which said slice configuration data occupy in the state of the shape of a sol, and a flow, cool immediately and it is made to gel and/or solidify. After giving a mask pattern to the part in this layer which carries out photo-curing, Irradiate light and photo-curing of the photo-setting resin constituent part where the mask pattern is not given is carried out. Subsequently, on said layer including the part which carried out photo-curing Three-dimensions data by computer the following slice configuration data which it comes to slice in parallel -- being based -- one kind in said photo-setting resin constituent carried out and thermoplastic polymer, or a thermoplastic polymer constituent -- or, while newly supplying two or more kinds to Taira and others by one layer in the state of the shape of a sol, and a flow After cooling immediately, making it gel and/or solidify and giving a mask pattern to the part in this layer which carries out photo-curing, irradiate light and a layer including the part which was made to carry out photo-curing of the photo-setting resin constituent part where the mask pattern is not given, and carried out photo-curing is made to form. It is the manufacture approach (it may be called below "the 3rd approach of this invention") of the solid molding object characterized by removing a multiple-times repeat and the photo-setting resin constituent by which photo-curing subsequently was not carried out from a stereo-like object for said actuation until the stereo-like object equivalent to three-dimensions data is formed.

[0011] And this invention (4) Above (1) or manufacture approach [ of (3) ]; given by carrying out jet injection of the light impermeability nature ink on the layer which gelled and/or solidified the mask pattern (5) Two or more kinds of photo-setting resin constituents, As one or more kinds of one or more kinds and the thermoplastic polymer of two or more kinds of thermoplastic polymers, a thermoplastic polymer constituent, or a photo-setting resin constituent, or a thermoplastic polymer constituent manufacturing -- having -- a stereo -- molding -- an object -- inside -- a presentation -- a color tone -- transparency -- kinetic property -- a physical characteristic -- and -- chemical property -- inside -- at least -- one -- a ** -- setting -- mutual -- differing -- a part -- forming -- a thing -- using -- said -- having carried out -- (-- one --) - (-- four --) -- either -- manufacture -- an approach --; -- and (6) One manufacture approach; of aforementioned (1) - (5) said whose slice configuration data are tomography data obtained from a living body's some or the whole body and whose solid molding objects are living body models is included.

[0012] Furthermore, this invention (7) Solid molding object; (8) obtained by one manufacture approach of aforementioned (1) - (6) Solid molding object [ of the above (7) which is a living body model ]; (9) Solid molding object [ of the above (8) which is the living body model which reproduced the gestalt of an affected part organization faithfully ]; (10) The color tone to which the part equivalent to the affected part organization in living body model differed from normal tissue, The solid molding object of the above (9) currently formed from the photo-curing resin or the thermoplastic polymer which has transparency, kinetic property, and/or a physical characteristic; It reaches. (11) The part equivalent to a different body tissue in a living body model is solid molding object [ of the above (8) currently formed from the photo-curing resin or the thermoplastic polymer with which a color tone, transparency, and kinetic property differ from a physical characteristic ];.

[0013]

[Embodiment of the Invention] This invention is explained below at a detail. With first, "the slice configuration data which comes to slice three-dimensions data by computer in parallel" which is the master data at the time of performing the 1st approach of this invention, the 2nd approach of this invention, and the

3rd approach (it being called the "this invention approach" when naming these generically below) of this invention 3-dimensional CAD data, the three-dimensions data which measure specific goods by the three dimensional measurer, and are obtained, Each slice configuration data (slice cross-section data) which slice thinly in parallel the three-dimensions data which photo some or all of a living body with tomographic equipment (CT scanner etc.), and are obtained by computer in order to perform solid molding, and are obtained are said. When manufacturing a living body model by this invention approach, it is adopted as data for each slice configuration data which slice thinly in parallel the three-dimensions data which photo some or all of a living body with tomographic equipment (CT scanner etc.), and are obtained as these slice configuration data by computer, and are obtained to form the photo-curing resin layer or solidification polymer layer in every layer. X-ray CT scan image data, such as the affected part, is more specifically changed into an STL format (method which approximates a three-dimensions free sculptured surface with the aggregate of a triangular patch) within a computer. Based on affected part STL data, according to the resin to be used, the class of polymer, etc., arrangement within molding equipment, the direction of a laminating (how to place a model), etc. are determined, and when a support is required, data are separately produced within a computer, and it adds to affected part model three-dimensions data. Furthermore, affected part model three-dimensions data with a support are sliced within a computer by the case, and it asks for the cross-section data (contour-line data) of each class, and let this be slice configuration data at the time of performing solid molding.

[0014] (I) -- 1st approach [ of this invention ]: -- the 1st approach of this invention is explained first. The 1st approach of this invention is an approach of performing an optical exposure and manufacturing a solid molding object, after giving a mask pattern to the part which carries out photo-curing using the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change, and it is common in the approach currently indicated by the international public presentation WO 01/No. 10632 official report described above at this point. However, to making it indispensable to use two or more kinds of photo-setting resin constituents, by the approach indicated by the international public presentation WO 01/No. 10632 official report, the 1st approach of this invention uses only one kind of photo-setting resin constituent, and is greatly different with this point. When based on the 1st approach of this invention using two or more kinds of photo-setting resin constituents Although the precise solid molding object by which the part where a color tone, transparency, kinetic property, and a physical characteristic differ from chemical property was complexly formed into one molding object depending on how to combine two or more kinds of photo-setting resin constituents to be used can be formed By the approach given in the international public presentation WO 01/No. 10632 official report, the solid molding object with which such [ as mentioned above ] a different part is complexly formed into one solid molding object is not formed.

[0015] By the 1st approach of this invention, two or more kinds of photo-setting resin constituents which cause sol-gel phase transition reversibly and quickly by the temperature change are used first. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. this -- 1 of two or more kinds of photo-setting resin constituents or two kinds or more are heated to the temperature which presents the shape of a sol, and it is made the shape of a sol (making it a fluidity), and supplies by one layer on a molding stage (molding table) in Taira and others above the area which said slice configuration data occupy. Under the present circumstances, it depends on the contents [ whether it is alike and only one kind of photo-setting resin constituent is supplied in said formation for one layer, or two or more kinds of photo-setting resin constituents are supplied ] of the slice configuration data used as the base at the time of forming this layer. in being the contents of data which slice configuration data become from one homogeneity part on the whole except for the profile of the outside (in for example, the case of the slice configuration data

equivalent to n= 1 in drawing 2 ), only one kind of photo-setting resin constituent supplies -- having -- this -- the stratification for one layer is made. moreover, when slice configuration data are the contents of data which are heterogeneity mutually and which have two or more parts (in for example, the case of the slice configuration data equivalent to n=p +1 in drawing 2 ) One (distributed) layer which was supplied separately, respectively, without mixing beforehand a number equivalent to [ two or more ] a part of photo-setting resin constituents [ two or more kinds of ] which are this heterogeneity, and has been arranged in each location in one layer according to the contents of slice configuration data is formed. Said one layer which supplied one kind or two kinds or more of photo-setting resin constituents, and was formed is cooled and gelled immediately below at the setting temperature. especially -- this -- the case where one layer is formed from two or more kinds of photo-setting resin constituents -- this -- it is necessary to gel promptly so that mixing between two or more photo-setting resin constituents within one layer may not arise

[0016] Subsequently, in said one layer which consists of photo-setting resin constituents, after giving a mask pattern to the part which carries out photo-curing, light is irradiated and photo-curing of the part where the mask pattern is not given is carried out. Then, on said resin layer including the part which carried out photo-curing Or while newly supplying two or more kinds to Taira and others by one layer by the shape of a sol, cooling gelation is carried out immediately. the following slice configuration data which come to slice three-dimensions data by computer in parallel -- being based -- one kind in said photo-setting resin constituent carried out -- After giving a mask pattern to the part in this photo-setting resin constituent layer which carries out photo-curing, light is irradiated and a resin layer including the part which was made to carry out photo-curing of the part where the mask pattern is not given, and carried out photo-curing is made to form. And the actuation described above until the stereo-like photo-curing object equivalent to three-dimensions data was formed is repeated two or more times. Finally, the photo-setting resin constituent by which photo-curing was not carried out is removed from the stereo-like photo-curing object generated above, and the solid molding object made into the purpose is obtained.

[0017] as the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change used by the 1st approach of this invention -- 60-200 degrees C -- especially -- the inside of a 80-150-degree C temperature requirement -- reversible -- and -- rapid -- the gel from a sol -- or the photo-setting resin constituent which causes phase transition from gel to a sol is preferably used from points, such as the formation ease of each class it is difficult from a photo-setting resin constituent, and the ease of the gelation after forming this layer. The photo-setting resin constituent used by the 1st approach of this invention contains the component for fluid accommodation and photopolymerization initiator for generally carrying out sol-gel phase transition of the photoresist component and photo-setting resin constituent which consist of photoresist oligomer and/or a monomer reversibly by the temperature change, and contains the other additives for resin, for example, a thixotropy nature manifestation agent, a bulking agent, a plasticizer, a stabilizer, a coloring agent, a flame retarder, an antioxidant, an antistatic agent, etc. if needed further.

[0018] As the above-mentioned photoresist component which constitutes the photo-setting resin constituent used by the 1st approach of this invention It can be used. both the photoresist oligomer used from the former in the photo-setting resin constituent, and/or a monomer -- although -- For example, the alkyl (meta) acrylate system of monofunctional or many organic functions, an epoxy (meta) acrylate system, A polyester (meta) acrylate system, a polyether (meta) acrylate system, The photoresist monomers and photoresist oligomer of an acrylate (meta) system, such as an urethane (meta) acrylate system; The bisphenol A system epoxy compound, A novolak system epoxy compound, an alicyclic epoxy compound, a polyphenol system epoxy compound, An epoxy system light cation hardenability resinous principle with conventionally well-known a poly glycidyl amine system, an alcoholic system epoxy compound, an ester system epoxy compound, etc. can be mentioned, and those one sort or two sorts or more can be used.

[0019] As a component for fluid accommodation for carrying out sol-gel phase transition of the photo-setting resin constituent reversibly by the temperature change, a polymer is used preferably. The photoresist component which consists of photoresist oligomer and/or a monomer It will be in the condition of having swollen without dissolving the polymer which is a component for fluid accommodation when it becomes below predetermined temperature. The whole photo-setting resin constituent gel in **** On the other hand, if the temperature of a photo-setting resin constituent turns into below predetermined temperature, a photoresist component will dissolve a polymer, or a polymer will fuse, and the whole photo-setting resin constituent will come to present a fluidity (the shape of a sol). A photo-setting resin constituent causes sol-gel phase transition reversibly by the temperature change with such a device.

[0020] As a polymer used as a component for fluid accommodation For example, the above mentioned homopolymer and above mentioned copolymer of a photoresist monomer, polybutadiene, Polyisoprene, polychloroprene, a polyvinyl chloride, polystyrene, The poly caprolactone, nitrile rubber, nylon, polyurethane, cel low SUTORI butyrate, A cel roast RINITO rate, polyethylene oxide, polyoxymethylene, A polyacrylonitrile, a collagen, polyvinyl alcohol, a polyvinylidene chloride, A polyvinyl butyral, an epoxy resin, a Polly 4-methyl pentene, Polyester, phenol resin, a urea-resin, melanin resin, diallyl phthalate resin, General-purpose polymers, such as silicone resin, a copolymer including the repeat unit which constitutes these polymers, Various kinds of bridge formation objects of said polymer or a copolymer, two or more sorts of those blend objects, the mixture of syndiotactic poly alkyl methacrylate and isotactic poly alkyl methacrylate, etc. can be mentioned. among those -- also coming out -- in this invention, the thing containing the mixture of syndiotactic poly alkyl methacrylate and isotactic poly alkyl methacrylate, especially the mixture of syndiotactic polymethylmethacrylate and isotactic polymethylmethacrylate is preferably used as a component for fluid accommodation.

[0021] Here, as the above mentioned syndiotactic polymethylmethacrylate, that whose percentage of three syndiotactic latticeworks (three continuous monomeric units) is about 60 - 90% is preferably used into a polymer, and what is about 65 - 80% is used more preferably. Moreover, as the above mentioned isotactic polymethylmethacrylate, that whose percentage of three isotactic latticeworks is about 80 - 95% is used desirable into a polymer, and what is about 85 - 95% is used more preferably. Syndiotactic polymethylmethacrylate: Although the mass ratio of isotactic polymethylmethacrylate changes with degrees of polymerization, tacticity, etc. of these polymers, it is desirable from points, such as the handling nature of a photo-setting resin constituent, that it is usually 1:10-10:1, and it is more desirable that it is 2:1. As for the content of the syndiotactic polymethylmethacrylate in a photo-setting resin constituent, and isotactic polymethylmethacrylate, it is desirable that it is more than 1 mass % to the mass of the whole photo-setting resin constituent, respectively, and it is more desirable that it is two to 30 mass %.

[0022] Especially by the living body model used for the purpose, such as medical-application simulation, the soft solid molding object which imitated not only the hard solid molding object that imitated the bone but a blood vessel, internal-organs tissue, etc. is called for in many cases. Therefore, when manufacturing a soft living body model by the 1st approach of this invention As a fluid accommodation component in a photo-setting resin constituent, for example, a butadiene, The elastomer which consists of the polymer or copolymers of conjugated diene, such as an isoprene and a chloroprene, The thermoplastic elastomer represented by the block copolymer which has a styrene system polymer block-(hydrogenation) diene system polymer block is used. It is good to prepare a photo-setting resin constituent to those elastomers combining what can show the property like [ a chain is comparatively long and ] a plasticizer among the above mentioned photopolymerization nature monomers or oligomer as a photoresist component, and to perform solid molding to them using it. In such a photo-setting resin constituent, the swelling degree of the elastomer particle by the photopolymerization nature monomer and/or oligomer changes with temperature, and a

photo-setting resin constituent comes to produce sol-gel phase transition reversibly by the temperature change with it.

[0023] The photopolymerization initiator used with the photo-setting resin constituent used by the 1st approach of this invention Any are sufficient as long as it is the photopolymerization initiator of the conventional known used as a photopolymerization initiator in the photopolymerization technique which uses ultraviolet rays and/or a visible ray. As an example A conventionally well-known benzophenone system compound, a benzoin alkyl ether system compound, A thioxan ton system compound, an anthraquinone system compound, a naphthoquinone system compound, a ketal system compound, alpha-diketone system compound, an acyl phosphine oxide system compound, etc. can be mentioned, and these one sort or two sorts or more can be used.

[0024] The photo-setting resin constituent used by the 1st approach of this invention may contain what is needlelike or fibrous like what spherical fine particles, such as globular form things, such as the detailed bulking agent which discovers thixotropy nature within limits which do not spoil the meaning of this invention if needed, for example, fumed silica, and colloidal silica, and silica gel, condensed, a tabular thing like a clay mineral, a whisker, or organic fiber. Furthermore, the photo-setting resin constituent used by the 1st approach of this invention may contain suitably other bulking agent, plasticizer, stabilizer, coloring agents, flame retarders, antioxidants, or antistatic agents within limits which do not spoil the meaning of this invention if needed.

[0025] By the 1st approach of this invention, two or more kinds of photo-setting resin constituents are used. As two or more kinds of photo-setting resin constituents used by the 1st approach of this invention It is based on the property required of the class of solid molding object finally manufactured, an application, and a solid molding object. In a solid molding object, for example, presentation; color tone; transparency;, for example, reinforcement, the rate of expanding, It is good to use what forms a mutually different part in at least one of chemical property, such as kinetic property and physical characteristics, such as an elastic modulus, a degree of hardness, flexibility, a compression property, thermal resistance, permeability, tractive characteristics, and cold resistance, and chemical resistance, weatherability, hydrolysis-proof nature, and a water resisting property. For example, what is necessary is just to use the combination of the photo-setting resin constituent containing a coloring agent, and the photo-setting resin constituent which does not contain a coloring agent, the combination of the photo-setting resin constituent containing a bulking agent, and the photo-setting resin constituent which forms a transparent photo-curing object, etc., when manufacturing the solid molding object which has the part where a color tone differs from transparency mutually. Moreover, what is necessary is just to use the combination of the photo-setting resin constituent which forms the photo-setting resin constituent which forms an elastic photo-curing object, and a hard photo-curing object etc., when manufacturing the solid molding object which has the part where degrees of hardness differ mutually. When manufacturing a living body model by the 1st approach of this invention, by choosing the combination of two or more kinds of photo-setting resin constituents by for example, the part equivalent to the affected parts, such as a gun organization, and the part equivalent to normal tissue By moreover, the part which is with the part equivalent to muscles, and the part equivalent to a blood vessel, and is further equivalent to muscles and the part equivalent to a bone If a photo-curing object is formed as it differs in a color tone, transparency, hardness, etc. mutually, a very useful precise living body model can be manufactured simply and quickly to education, an object for training, etc. of the simulation before an operation, and a medicine student.

[0026] In the 1st approach of this invention, in case the 1st layer is formed on a molding stage (molding table) Moreover, are in charge of forming one more layer on the resin layer which already carried out photo-curing. Especially the approach of supplying a photo-setting resin constituent on a molding stage or

the resin layer which carried out photo-curing is not restricted. For example, two or more containers which hold each of two or more kinds of photo-setting resin constituents according to an individual, and may be made to discharge by the shape of a sol (tank), By the feeder equipped with the pressurization means for making a photo-setting resin constituent breathe out from a container, the control means of discharge quantity or the amount of supply, and the applicator (X-Y plotter equipment) that has the location detection means of the direction of X-Y still more preferably The approach of extruding one kind of two or more kinds of photo-setting resin constituents or two kinds or more a constant rate every according to each slice configuration data for forming each class to the position on a molding stage or the resin layer which carried out photo-curing etc. is mentioned. Moreover, the distorted effect based on curing shrinkage may appear in the form of the distortion of a photo-curing resin layer (defect of smoothness) as the number of laminatings of the resin layer which carried out photo-curing increases and the thickness of a photo-curing object becomes thick. In this case, in order to avoid such a phenomenon, you may establish a level detection means to detect the smoothness of the resin layer which carried out photo-curing, and may also construct the program which adjusts and controls the discharge quantity from an applicator. Moreover, the supplied photo-setting resin constituent may be level sounded by RIKOTA as an option.

[0027] Moreover, in the 1st approach of this invention, the approach of printing a mask pattern on the layer which can adopt the approach of arbitration as an approach of giving a mask pattern, on the layer which consists of a photo-setting resin constituent, for example, consists of a photo-setting resin constituent using an ink jet means using light impermeability nature ink, the approach of arranging the bright films (PET film etc.) in which the mask pattern was formed, between a photo-setting resin constituent layer and the light source, etc. can be mentioned. Among those, but the approach of printing a mask pattern with an ink jet means using light impermeability nature ink is adopted preferably. Namely, the photo-setting resin constituent used by the 1st approach of this invention The layer which is the resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change, and was formed using this photo-setting resin constituent Since gel (the shape of a solid) is presented in case a mask pattern is given, even if it sprays light transmission nature ink on this layer and prints a mask pattern directly, a mask pattern does not collapse. When based on this approach, a desired mask pattern can be formed very good in a short time. In that case, the ink which melted one sort of ultraviolet ray absorbents, such as the ink and the benzophenone system which distributed carbon black, ferrous oxide, titanium oxide, and other detailed and opaque powder with the thickener in the water containing a surface active agent or a solvent, a benzotriazol system, a salicylic-acid system, and a hindered amine system, or two sorts or more to the thickener, the solvent, etc. can be mentioned as light impermeability nature ink used for formation of a mask pattern, for example.

[0028] In the 1st approach of this invention, what consists of a case which prevents the exsorption to the control means for controlling control, irradiation time, etc. of the lamp means by which a mercury-vapor lamp, a xenon lamp, a metal halide lamp, a halogen lamp, etc. are conventionally well-known, and optical system, the cooling means of a lamp means or a control means, and the exterior of light is preferably used as a light irradiation device for stiffening the layer which consists of a photo-setting resin constituent. As light may be irradiated on the whole top face of the photo-setting resin constituent given on the molding stage (laid) at homogeneity, you may be the turntable which may be equipped with two or more lamps, and a molding stage rotates. However, to take a turntable method, it is necessary to establish the positioning means of a firm table.

[0029] moreover, from the stereo-like photo-curing object which finished and generated all the required photo-curing processes in the 1st approach of this invention In removing the photo-setting resin constituent by which photo-curing was not carried out, and obtaining a solid molding object How to flush a

non-hardened photo-setting resin constituent using the solvent with which a photo-curing object does not deteriorate, Which approaches, such as an approach of performing said approach while applying a supersonic wave, and the approach of making a non-hardened photo-setting resin constituent part the shape of a sol with heating, without using a solvent, and making it separate from a photo-curing (fluidizing) object, may be adopted. Smeariness remains in the solid molding object obtained after separating a non-hardened photo-setting resin constituent part from a photo-curing object, when there is a possibility of soiling a hand etc., light may be irradiated again at a solid molding object, and hardening may be completed.

[0030] The solid molding object made into the purpose can be manufactured with simply and sufficient productivity with good dimensional accuracy, without using a support etc., even if a solid molding object is the thing of an overhang configuration when manufacturing a solid molding object by the 1st approach of this invention. From this point, the precise living body model which reproduced faithfully some living bodies or the gestalt of the whole body can be manufactured by the 1st approach of this invention. The living body model which distinguished the liver tissue invaded by the gun and normal liver tissue in color tone by the 1st approach of this invention can be manufactured. Although not limited, in order to manufacture such a living body model It responds to each tomography data (each slice configuration data of liver) obtained from a living body's liver part. For example, two or more kinds of photo-setting resin constituents with which a color tone and transparency differ from a presentation Each X-Y plotter equipment which has a nozzle according to individual is used. To the position on the stage for living body model manufacture Make it correspond to each of the liver tissue invaded by the gun and normal liver tissue, and it supplies separately. A mask pattern is given to parts which you want to harden, such as the unnecessary section or a border line, using an ink jet means to inject light impermeability nature ink etc. Perform an optical exposure from on this photo-setting resin constituent and a mask pattern, and the hardening resin layer corresponding to each slice configuration data of liver is made to form. The approach of removing the photo-setting resin constituent part which did not harden said actuation at the end repeatedly until the Mitsuzo form object equivalent to the whole liver was formed from a part for photo-curing Monobe etc. is adopted. The precise liver model by which a color tone and transparency differ from other physical properties can be manufactured by the part which the liver tissue invaded by the gun deserves by it, and the part equivalent to normal liver tissue.

[0031] Moreover, if it gives the part equivalent to the border line between different body tissues (boundary section), without using a mask pattern by the 1st approach of this invention only for formation of the rim equivalent part of a body tissue, the living body model which has a clearance can be formed in the boundary of the part which is equivalent to a different body tissue from the photo-setting resin constituent with which light was covered not hardening by the part. Moreover, the part equivalent to a living body's parenchyma is formed from elastic photo-curing resin, the part equivalent to a living body's hard organization is formed from hard photo-curing resin, and if a clearance is formed among both organizations by the above mentioned masking approach, the real living body model approximated by the living body can also be formed. <BR>

[0032] (II) 2nd approach [ of this invention ]:, next the 2nd approach of this invention are explained. Two or more kinds of the thermoplastic polymers or the thermoplastic polymer constituents which have preferably 60-250 degrees C of flow beginning temperature in the range of 80-180 degrees C are used for the 2nd approach of this invention. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. this -- one kind in two or more kinds of thermoplastic polymers, or a thermoplastic polymer constituent, or two kinds or more From the nozzle which it comes to attach in the X-Y plotter equipment according to individual prepared for every thermoplastic polymer or thermoplastic polymer constituent On a molding stage (molding table) in the state of a flow (melting condition) in Taira and others, respectively One layer While supplying by the shape of a field, cooling solidification is carried out

immediately. Subsequently for example, on the layer which carried out cooling solidification Three-dimensions data by computer It slices in parallel. To the becoming following slice configuration data The thermoplastic polymer based and described above Or one kind in a thermoplastic polymer constituent, or two kinds or more While newly supplying Taira and others by one layer in the state of a flow (melting condition), respectively from the nozzle which it comes to attach in the X-Y plotter equipment according to the above mentioned individual prepared for every thermoplastic polymer or thermoplastic polymer constituent, cooling solidification is carried out immediately. It is the approach of repeating said actuation two or more times, and manufacturing a solid molding object until the stereo-like solidification object equivalent to three-dimensions data is formed.

[0033] In forming said polymer layer for one layer, in the 2nd approach of this invention, it depends on the contents [ whether in order to form the polymer layer for this one layer, only one kind in a thermoplastic polymer or a thermoplastic polymer constituent is supplied, or two or more kinds are supplied ] of the slice configuration data used as the base at the time of forming this layer. when slice configuration data are the contents of data which consist of one homogeneity part on the whole (in for example, the case of the slice configuration data equivalent to n=p +1 in drawing 6 ), only one kind of thermoplastic polymer or a thermoplastic polymer constituent supplies -- having -- this -- one layer is formed. moreover, when slice configuration data are the contents of data which are heterogeneity mutually and which have two or more parts (in for example, the case of the slice configuration data equivalent to n=p +2 in drawing 6 ) it is this heterogeneity -- into a part two or more A corresponding number of two or more kinds of thermoplastic polymers or thermoplastic polymer constituents are separately supplied from each nozzle which it comes to attach in the X-Y plotter equipment according to individual, it is arranged in each location in one layer according to the contents of slice configuration data, and one layer is formed. Said one layer which supplied one kind or two kinds or more of thermoplastic polymers or thermoplastic polymer constituents, and was formed is cooled and solidified immediately below at the solidification temperature. especially -- this -- when one layer is formed from two or more kinds of thermoplastic polymers or thermoplastic polymer constituents, it is necessary to solidify promptly so that mixing may not arise between two or more thermoplastic polymers within one layer, or a thermoplastic polymer constituent

[0034] At a room temperature, if said thermoplastic polymer or the thermoplastic polymer constituent used by the 2nd approach of this invention presents the shape of a solid-state and is heated more than the flow beginning temperature (60-250 degrees C), it will flow. If the flow beginning temperature of a thermoplastic polymer or a thermoplastic polymer constituent is in within the limits which is 60-250 degrees C by the 2nd approach of this invention as two or more kinds of thermoplastic polymers or thermoplastic polymer constituents To the same thermoplastic polymer as the combination of two or more kinds of thermoplastic polymers, one thermoplastic polymer, and it from which a class differs, for example, a bulking agent, Combination with the thermoplastic polymer constituent which comes to add additives, such as a coloring agent, Although the same thermoplastic polymer is used as the base, any, such as combination of two or more kinds of thermoplastic polymer constituents with which presentations differ, and combination of two or more kinds of thermoplastic polymer constituents which use a mutually different thermoplastic polymer as the base, may be adopted. As the thermoplastic polymer which can be used by the 2nd approach of this invention, or a thermoplastic polymer constituent, the thermoplastic polymer constituent which uses one sort of the copolymers of a wax, polyethylene, polypropylene, an ethylene-vinylacetate copolymer, an ethylene methyl methacrylate copolymer, transformer polyisoprene, the poly caprolactone, methyl methacrylate, and other alkyl (meta) acrylate or these polymers or two sorts or more as the base is mentioned, for example. Among these, since a wax is easily removable from a body part by performing hot water washing and steam washing by the final process of the production process of a solid molding object In

case a solid molding object is manufactured according to the 2nd approach of this invention using other thermoplastic polymers and/or ********** polymer constituents A thermoplastic polymer and/or a thermoplastic polymer constituent can overflow into the method of outside too much the profile of the solid molding object made into the purpose, and it can be used also as a separation means (auxiliary material) not to lose the configuration precision of a solid molding object. Moreover, by the 2nd approach of this invention, according to the configuration of a solid molding object etc., it may function as a support during solid molding, and after termination of solid molding may perform solid molding using the thermoplastic polymer or the thermoplastic polymer constituent removed from a solid molding object with two or more kinds of the thermoplastic polymers or the thermoplastic polymer constituents which constitute a solid molding object. The thermoplastic polymer or the thermoplastic polymer constituent used by the 2nd approach of this invention may contain one sort, such as a bulking agent, a plasticizer, a stabilizer, a coloring agent, a flame retarder, an antioxidant, and an antistatic agent, or two sorts or more within limits which do not spoil the meaning of this invention if needed.

[0035] By the 2nd approach of this invention, as two or more kinds of thermoplastic polymers or thermoplastic polymer constituents It is based on the property required of the class of solid molding object finally manufactured, an application, and a solid molding object. In a solid molding object, for example, presentation; color tone; transparency;, for example, reinforcement, the rate of expanding, What forms a mutually different part in at least one of chemical property, such as kinetic property and physical characteristics, such as an elastic modulus, a degree of hardness, flexibility, a compression property, thermal resistance, permeability, tractive characteristics, and cold resistance, and chemical resistance, weatherability, hydrolysis-proof nature, and a water resisting property, is used. For example, what is necessary is just to use the combination of the thermoplastic polymer constituent containing a coloring agent, and the thermoplastic polymer which does not contain a coloring agent, combination with the thermoplastic polymer which forms the thermoplastic polymer constituent containing a bulking agent, and a transparent photo-curing object, etc., when manufacturing the solid molding object which has the part where a color tone differs from transparency mutually. Moreover, what is necessary is just to use the combination of a supple thermoplastic polymer, a thermoplastic polymer constituent and a hard thermoplastic polymer, or a thermoplastic polymer constituent etc., when manufacturing the solid molding object which has the part where degrees of hardness differ mutually. As well as the case of the 1st approach of this invention when manufacturing a living body model by the 2nd approach of this invention, by choosing the combination of two or more kinds of thermoplastic polymers, or a thermoplastic polymer constituent By for example, the part equivalent to the affected parts, such as a gun organization, and the part equivalent to normal tissue By the part which is with the part equivalent to muscles, and the part equivalent to a blood vessel, or is equivalent to muscles, and the part equivalent to a bone A mutually different precise living body model in a color tone, transparency, hardness, etc. which is useful to education, an object for training, etc. of the simulation before an operation and a medicine student can be manufactured simply and quickly.

[0036] As an approach of supplying the melt of a thermoplastic polymer or a thermoplastic polymer constituent, and forming the polymer layer for one layer on a molding stage (molding table), in the 2nd approach of this invention For example, the container which comes to fill up a thermoplastic polymer or a thermoplastic polymer constituent (tank), A means to heat a thermoplastic polymer or a thermoplastic polymer constituent more than flow beginning temperature, RETA is used. the application equipped with a means to control the means which carries out the quantum of the discharge quantity from the nozzle of the fused thermoplastic polymer or a thermoplastic polymer constituent, the location detection means in the direction of X-Y of a nozzle, and them -- After extruding the melt of a thermoplastic polymer or a thermoplastic polymer constituent from this applicator a constant rate every to the position on a stage, the

approach of spraying on the part which leads the flow of Ayr generated with a fan's etc. means to thin passage, and requires cooling, and solidifying is mentioned. When the projection has arisen on the front face of the layer of the thermoplastic polymer supplied on the molding table or the already solidified polymer layer, or a thermoplastic polymer constituent and it has not become a smooth field, in order to obtain the solid molding object which is excellent in dimensional accuracy, the means for carrying out flattening of the front face of the layer of the melt of a thermoplastic polymer or a thermoplastic polymer constituent may be established. Although the distorted effect based on contraction of a thermoplastic polymer or a thermoplastic polymer constituent may appear in the form of lack of the surface smoothness in a solid molding object as the number of laminatings of the layer of the solidified thermoplastic polymer or a thermoplastic polymer constituent increases and the thickness of a solidification object becomes thick If required, a level detection means to detect the surface smoothness of the solidified polymer layer can be established, and the program which adjusts and controls the discharge quantity from an applicator can also be constructed.

[0037] The 3rd approach of this invention : (III) The 3rd approach of this invention One or more kinds of the photo-setting resin constituent which causes sol-gel phase transition reversibly and quickly by the temperature change combining the 1st above mentioned approach of this invention and the 2nd above mentioned approach of this invention, One or more kinds of the thermoplastic polymer in the range whose flow beginning temperature is 60-250 degrees C, or a thermoplastic polymer constituent are used. It is based on the slice configuration data which come to slice three-dimensions data by computer in parallel. One kind in the above mentioned photo-setting resin constituent, a thermoplastic polymer, and a thermoplastic polymer constituent, or two kinds or more in the state of the shape of a sol, and a flow While supplying by one layer on a molding stage (molding table) in Taira and others above the area which said slice configuration data occupy, it is made to gel and/or solidify immediately. After giving a mask pattern to the part in this layer which carries out photo-curing, Irradiate light and photo-curing of the photo-setting resin constituent part where the mask pattern is not given is carried out. Subsequently, on said layer including the part which carried out photo-curing Three-dimensions data by computer the following slice configuration data which it comes to slice in parallel -- being based -- one kind in said photo-setting resin constituent carried out and thermoplastic polymer, or a thermoplastic polymer constituent -- or, while newly supplying two or more kinds to Taira and others by one layer in the state of the shape of a sol, and a flow After making it gel and/or solidify immediately and giving a mask pattern to the part in this layer which carries out photo-curing, irradiate light and a layer including the part which was made to carry out photo-curing of the photo-setting resin constituent part where the mask pattern is not given, and carried out photo-curing is made to form. It is the approach of removing a multiple-times repeat and the photo-setting resin constituent by which photo-curing subsequently was not carried out from a stereo-like object for said actuation, and manufacturing a solid molding object until the stereo-like object equivalent to three-dimensions data is formed.

[0038] By the 3rd approach of this invention, the same thing as the thermoplastic polymer or the thermoplastic polymer constituent used by the photo-setting resin constituent and the 2nd approach of this invention which are used by the 1st approach of this invention as a photo-setting resin constituent, a thermoplastic polymer, or a thermoplastic polymer constituent can be used. By the 3rd approach of this invention, since it is a thing using a photo-setting resin constituent, a thermoplastic polymer or the resin of varieties called a thermoplastic polymer constituent and a polymer, and a polymer constituent, combination very various as two or more sorts of those combination is possible, and a more precise solid molding object can be formed at this point according to the application of a solid molding object etc. By the 3rd approach of this invention, the same approach and equipment as the 1st approach of this invention and/or the 2nd approach of this invention are adopted also in the separation approach of the photo-setting resin constituent

which is not carrying out photo-curing from the formation approach of a mask pattern, photo-curing and/or the formation approach of a layer which carried out cooling solidification or formation equipment, and the solid molding object in a final process etc.

[0039] When it is in charge of adopting the 3rd approach of this invention and manufacturing a living body model, for example, a living body's profile section (body surface section) is previously manufactured with a thermoplastic polymer or a thermoplastic polymer constituent, it becomes Tsutsumi for the profile section which consists of a thermoplastic polymer or a thermoplastic polymer constituent to hold a photo-setting resin constituent into a part in the living body, and there is an advantage it becomes unnecessary to supply an expensive photo-setting resin constituent too much. Moreover, if it programs to supply a thermoplastic polymer or a thermoplastic polymer constituent, and a photo-setting resin constituent by turns in case the living body model reproducing two or more tissues in the living body is manufactured by the 3rd approach of this invention A trouble with which the part where each organization deserves [ in / for pasting up mutually / a living body model ] a thermoplastic polymer or a thermoplastic polymer constituent, and a photo-setting resin constituent using **** stops sticking and separating is avoidable.

---

EXAMPLE

---

[Example] Although an example explains this invention concretely below, this invention is not limited to an example. The contents of the photo-setting resin constituent used in the following examples 1-3 and/or a thermoplastic polymer (thermoplastic polymer constituent) are shown in the following Table 1 and 2.

[0041]

[Table 1]

[0042]

[Table 2]

[0043] In addition, the monomer indicated to the above-mentioned Table 1 and 2, or the cable address and the contents of a polymer are as follows.

- An MMA:methyl-methacrylate monomer and PMMA : polymethyl methacrylate (Kuraray Make: parapet LW- 1000, syndiotactic comparatively 65%)
- i-PMMA : isotactic-polymethyl methacrylate (what was manufactured according to anionic polymerization, using t-butyl magnesium star's picture as an initiator; isotactic comparatively 90%)
- 2EHA : A 2-ethylhexyl-acrylate monomer and a red color: "#310" by Kioritz chemistry incorporated company
- PE:polyethylene ("nova tech HJ-290" by Japan Polychem, Inc.), and white pigments : titanium oxide ("TIPAQUE" by Ishihara Sangyo Kaisha, Ltd.)

**IR: Polyisoprene rubber ("IR-10" By Kuraray)

- Oil : process oil ("PW-380" by Idemitsu petrochemical incorporated company)

[0044] <<example 1>> Manufacture] of a liver model which has [lesion section

(1) In this example 1, the liver model equivalent to the liver which has the lesion section equivalent to drawing 1 was manufactured according to the 1st approach of this invention, using the photo-setting resin

constituent C (elasticity red) as an object for parts equivalent to the lesion section, using the photo-setting resin constituent B (elasticity transparence) as two kinds of photo-setting resin constituents, and an object for parts which is specifically equivalent to the normal section. Namely, two nozzles combined with the X-Y plotter equipment according to individual which can apply a photo-setting resin constituent on the molding stage (molding table) which was connected with two resin tanks and the resin tank of these two individuals which have a heating means, and which can be moved up and down, And the equipment which is equipped with the ink jet head combined with the X-Y plotter equipment which can print ultraviolet-rays protection-from-light nature ink as a main mechanical component, and is equipped with an ultraviolet ray lamp as the light source is used. According to the procedure shown in drawing 3 - drawing 5 , the model of the liver shown with the schematic diagram of drawing 1 which has a part equivalent to the lesion section in the part equivalent to the normal section was manufactured.

[0045] (2) After changing into an STL format a patient's liver data which have the lesion section shown in the schematic diagram of drawing 1 obtained by CAT by computer, as further shown in drawing 2 , it sliced by computer and asked for the slice configuration data (slice cross-section data) of each class.

(3) In drawing 2 , the slice cross-section data which do not contain the lesion section are from the 1st layer of n= 1 to the layer of n=p. The photo-setting resin constituent B was independently used for the Mitsuzo form for these layers, and it performed it by the approach shown in the schematic diagram of drawing 3 . Namely,

(i) Process which carries out heating fusion of the photo-setting resin constituent B at 120 degrees C, makes it the shape of a sol (liquefied), supplies by one layer on the molding stage 3 from a nozzle 1, makes it gel with air cooling immediately, and forms a flozen layer (solidifying) 4-1 (** of drawing 3 );

(ii) Process which forms the protection-from-light nature mask pattern 6-1 by the ink jet head 5 on the flozen layer 4-1 formed above based on slice cross-section data (** of drawing 3 );

(iii) Process which forms the resin section 8-1 which performed the field exposure and carried out photo-curing into the layer with the black light 7 (** of drawing 3 );

(iv) After dropping the molding stage 3 by one layer, the resin section 8-1 which was formed with the above (iii) and which carried out photo-curing on the field of the layer (n= 1) included in a layer Process which supplies by one layer, carries out air cooling of the photo-setting resin constituent B heated and fused at 120 degrees C immediately, gels it from a nozzle 1, and forms a flozen layer (solidifying) 4-2 (** of drawing 3 );

(v) Process; repeated until the layer of n=p is formed in the process of said (ii) - (iv) based on each slice cross-section data to the flozen layer 4-2 generated above was adopted, and the Mitsuzo form of the part which corresponds by the layer of n=p was performed from the 1st layer of n= 1.

[0046] (4) In drawing 2 , the slice cross-section data containing the lesion section are to the layer of n=p +1 to n=q. Then, following the Mitsuzo form of the above (3), both the photo-setting resin constituent B and the photo-setting resin constituent C were used, and the Mitsuzo form to the layer of n=p +1 to n=q was performed by the approach shown in the schematic diagram of drawing 4 . Namely, (i) It supplies on the layer (layer equivalent to n=p) containing the resin section which carried out heating fusion, made the photo-setting resin constituent B in each tank, and the photo-setting resin constituent C the shape of a sol (liquefied), and carried out photo-curing to 120 degrees C by one layer from the nozzle 1 and the nozzle 2, respectively. It is immediately made gel with air cooling (solidifying). The part which consists of a photo-setting resin constituent B The process in which the part which consists of a photo-setting resin constituent C forms flozen layer 4-p1 distributed in one layer (**' of drawing 4 ); (ii) Protection-from-light nature mask pattern 6-p1 by the ink jet head 5 based on slice cross-section data on flozen layer 4-p1 generated above Process to form (**' of drawing 4 );

(iii) Process which carries out a field exposure with a black light 7, and forms resin section 8-p1 which carried out photo-curing (**' of drawing 4 );

(iv) After dropping the molding stage 3 by one layer, photo-curing resin section 8-p1 formed with the above (iii) on the field of the layer (layer equivalent to n=p +1) included in a layer Supply the photo-setting resin constituent B and the photo-setting resin constituent C which were heated and fused at 120 degrees C by one layer through a nozzle 1 and a nozzle 2, and it is immediately made gel with air cooling (solidifying). Process which forms flozen layer 4-p2 from which the photo-setting resin constituent B section and the photo-setting resin constituent C section were distributed in one layer (**' of drawing 4 );
(v) Process; repeated until the layer of n=q forms the process of said (ii) - (iv) based on slice cross-section data to flozen layer 4-p2 generated above respectively was adopted, and the Mitsuzo form of the part (part which has a part equivalent to the lesion section) to the layer of n=p +1 to n=q was performed.
[0047] (5) Since the molding object with which the molding section 9 which consists of resin which carried out photo-curing with the photo-setting resin constituent 10 which is not carrying out photo-curing was surrounded mostly was acquired as the above-mentioned process showed to (a) of drawing 5 By heating it for 5 minutes at 120 degrees C, fusing the part of the non-hardened photo-setting resin constituent 10, and dissociating from the molding (making it shape of sol) object 9, the liver model which is shown in (b) of drawing 5 and which has a part equivalent to the lesion section was obtained. Adhesion between the part which is equivalent to the lesion section since the part which the part which is equivalent to the lesion section by this liver model is elasticity red, and the part equivalent to the normal section is elasticity transparence, and both parts have living body liver and a similar elastic modulus, and is moreover further equivalent to the lesion section, and the part equivalent to the normal section are formed from the homogeneous photo-setting resin constituent, although color tones differ, and the part equivalent to the normal section was good. And since the condition of the part equivalent to the lesion section was easily checked from the outside by this liver model, it was very useful in the simulation before an operation, a medicine student's education, etc.
[0048] <<example 2>> Manufacture] of a liver model which has [lesion section
(1) The liver model [the liver model shown in (b) of drawing 5 ] equivalent to the liver which has the lesion section equivalent to drawing 1 in this example 2 One kind of thermoplastic polymer, two kinds of thermoplastic polymer constituents, and a (for a support; hard translucence), b (for [ equivalent to the normal section ] parts; rubber-like transparence) and c (for [ equivalent to the lesion section ] parts; rubber-like red) in Table 2 were specifically used, and it manufactured according to the 2nd approach of this invention. The liver model shown in drawing 5 was manufactured by manufacturing the solid molding object of the configuration shown in drawing 8 in consideration of a support part in that case, and separating the support section. Namely, three nozzles combined with the X-Y plotter equipment according to individual which can apply a thermoplastic polymer or a thermoplastic polymerization body composition object on the molding stage (molding table) which was connected with three polymer tanks and the polymer tank of these three individuals which have a heating means, and which can be moved up and down, And the procedure which shows a cooling system in drawing 7 using the equipment which it has as a main mechanical component is followed. After manufacturing the solid molding object with a support shown with the schematic diagram of drawing 8 which has a part equivalent to the lesion section in the part equivalent to the normal section, and has the support section, the liver model shown in drawing 5 was manufactured by separating the support section from this solid molding object.
[0049] (2) After changing into an STL format a patient's liver data which have the lesion section shown in the schematic diagram of drawing 1 obtained by CAT by computer, as further shown in drawing 6 , it sliced by computer and asked for the slice configuration data (slice cross-section data) of each class. In drawing 6 , the slice cross-section data which contain the support section and the normal section excluding the lesion section are from the 1st layer of n= 1 to the layer of n=p. The thermoplastic polymer a (for the support

sections) and the thermoplastic polymer constituent c (for the normal sections) photo-setting resin constituent were used for the Mitsuzo form for these layers, and it performed them by the approach shown in this schematic drawing of drawing 7 . Namely, (i) Based on the 1st slice cross-section data, carry out heating fusion, make the thermoplastic polymer a into the letter of a flow, and it is supplied on the molding stage 3 through a nozzle 11 at 110 degrees C. At 190 degrees C, carry out heating fusion, make the thermoplastic polymer constituent b into the letter of a flow, and it is supplied on the molding stage 3 through a nozzle 12 at coincidence. Process which is immediately cooled and solidified with a cooling system and forms the 1st flozen layer 14-1 over which the part which consists of a thermoplastic polymer a, and the part which consists of a thermoplastic polymer constituent b are distributed in one layer (** of drawing 7 );
(ii) After dropping the molding stage 3 by one layer, on the field of the flozen layer 14-1 (layer equivalent to n= 1) formed with the above (i) Based on the 2nd slice cross-section data, carry out heating fusion, make the thermoplastic polymer a into the letter of a flow, and it is supplied to 110 degrees C through a nozzle 11. Carry out heating fusion, make the thermoplastic polymer constituent b into the letter of a flow, and it is supplied to 190 degrees C through a nozzle 12 at coincidence. Process which is immediately cooled and solidified with a cooling system and forms the 2nd flozen layer 14-2 over which the part which consists of a thermoplastic polymer a, and the part which consists of a thermoplastic polymer constituent b are distributed in one layer (** of drawing 7 );
(iii) Process; repeated until the layer of n=p is formed in the process of the above (ii) based on each slice cross-section data to the flozen layer 14-2 generated above was adopted, and the part which corresponds by the layer of n=p was molded from the 1st layer of n= 1.
[0050] (3) After dropping the molding stage 3 by one layer, next, on flozen layer 14-p (flozen layer equivalent to n=p) formed with the above (2) Based on slice cross-section data, heating fusion was carried out, and the thermoplastic polymer constituent b was made into the letter of a flow, was supplied to 190 degrees C from the nozzle 12, and was immediately cooled and solidified with the cooling system, and the flozen layer (flozen layer equivalent to n=p +1) which consists of a thermoplastic polymer constituent b was formed (** of drawing 7 ).
(4) (i) Then, after dropping the molding stage 3 by one layer, On the flozen layer (flozen layer equivalent to n=p +1) formed above (4) Based on slice cross-section data, carry out heating fusion, make the thermoplastic polymer constituent b (for [ equivalent to the normal section ] parts; transparence) into the letter of a flow, and it is supplied to 190 degrees C through a nozzle 12. Carry out heating fusion, make the thermoplastic polymer constituent c (for [ equivalent to the lesion section ] parts; red) into the letter of a flow, and it is supplied to 190 degrees C through a nozzle 13 at coincidence. It was made to cool and solidify with a cooling system immediately, and the flozen layer (flozen layer equivalent to n=p +2) from which the part which consists of a thermoplastic polymer constituent b, and the part which consists of a thermoplastic polymer constituent c are distributed in one layer was formed.
(ii) The process repeated until the layer of n=q is formed in the same process as the above (i) based on each slice cross-section data to the flozen layer generated above (i) was adopted, and the solid molding object which has the part 17 equivalent to the part 16 and the lesion section equivalent to the support section 15 as shown in drawing 8 , and the normal section was manufactured.
[0051] (5) By heating the solid molding object of drawing 8 obtained above (5) at 110 degrees C, only the support section 15 carried out melting liquefaction, it dissociated from the body section which consists of a part 16 and a part 17 easily, and the liver model which is shown in (b) of drawing 5 and which has a part equivalent to the lesion section was obtained. The part which is equivalent to the lesion section by this liver model is red, and the part equivalent to the normal section is transparent and colorless. And although color tones differ, since the part which both parts have living body liver and a similar elastic modulus, and is

further equivalent to the lesion section, and the part equivalent to the normal section are formed from the homogeneous thermoplastic polymer constituent, Adhesion between the part equivalent to the lesion section and the part equivalent to the normal section was good, and since the condition of the part equivalent to the lesion section was easily checked from the outside, it was very useful in the simulation before an operation, a medicine student's education, etc.

[0052] <<example 3>> ([manufacture of the living body model which has a muscular equivalent part and a bone equivalent part] 1) In this example 3 The photo-setting resin constituent A (shape of the skull; for [ this ] parts hard transparence), the photo-setting resin constituent C (for muscular equivalent parts; ** type red), and three kinds of polymers of the thermoplastic polymer a (; for the space section equivalent parts between a bone and muscles -- hard -- translucent) are used. The living body model which has the muscular equivalent part and bone equivalent part equivalent to drawing 9 according to the 3rd approach of this invention, and has space between a muscular equivalent part and a bone equivalent part was manufactured. namely, [ which can apply a photo-setting resin constituent and a thermoplastic polymer on three resin (polymer) tanks by which it has a heating means, and the molding stage (molding table) which can be moved up and down ] Three nozzles combined with the X-Y plotter equipment according to individual connected with said three tanks, At the process shown after following (2) using the equipment which is equipped with the ink jet head and cooling system which were combined with the X-Y plotter equipment which can print ultraviolet-rays protection-from-light nature ink as a main mechanical component, and is equipped with an ultraviolet ray lamp as the light source The living body model which has a muscular equivalent part equivalent to drawing 9 and a bone equivalent part was manufactured.

[0053] (2) After changing into an STL format the living body section data obtained by CAT by computer, as further shown in drawing 10 , it sliced by computer and asked for the slice configuration data (slice cross-section data) of each class.

(3) Based on the slice cross-section data obtained above (2), molding in the layer (layer equivalent to the slice cross-section data of n= 1 - n=p in drawing 10 ) which has only the part which is equivalent to muscles in one layer was performed by adopting the process same in (3) of an example 1 using the photo-setting resin constituent C.

(4) Next, molding in the layer (layer equivalent to the slice cross-section data of n=p +1 in drawing 10 - n=q) which has a part equivalent to the part which is equivalent to muscles in one layer, the part equivalent to space, and a bone was performed by adopting the process same in (4) of an example 1 using the photo-setting resin constituent A, the photo-setting resin constituent C, and the thermoplastic polymer a.

(5) Then, molding in the layer (layer equivalent to the slice cross-section data of n=q +1 in drawing 10 - n=r) which has the part which is equivalent to a bone in one layer, and a part equivalent to space was performed by adopting the process same in (4) of an example 1 using the photo-setting resin constituent A and the thermoplastic polymer a.

[0054] (6) Next, molding in the layer (layer equivalent to the slice cross-section data after n=r +1 in drawing 10 ) which has only a part equivalent to a bone in one layer was performed by adopting the process same in (3) of an example 1 using the photo-setting resin constituent A.

(7) Since the molding object with which the molding section which consists of resin which carried out photo-curing with the photo-setting resin constituent 10 which is not carrying out photo-curing, and a solidified thermoplastic polymer was surrounded mostly was acquired as the above-mentioned process showed to drawing 11 By heating it for 5 minutes at 120 degrees C, fusing the thermoplastic polymer a equivalent to non-hardened the part and the space section of the photo-setting resin constituent 10, and dissociating from a molding object The living body model which has the muscular equivalent part and bone equivalent part equivalent to drawing 9 , and has space between a muscular equivalent part and a bone

equivalent part was manufactured. By this living body model, a muscular equivalent part is elasticity red, a bone equivalent part is hard transparence, and since space moreover exists between a muscular equivalent part and a bone equivalent part similarly in a living body, it can know the actual organization in a living body easily and certainly.

---

DESCRIPTION OF DRAWINGS

---

[Brief Description of the Drawings]

[Drawing 1] It is the schematic diagram showing the example of the liver which has the lesion section.

[Drawing 2] It is drawing showing the slice configuration data (slice cross-section data) of each class obtained from the data of the liver of drawing 1 .

[Drawing 3] It is drawing showing the process of front ** at the time of manufacturing the liver model which is equivalent to the liver of drawing 1 by the 1st approach of this invention in the example 1.

[Drawing 4] It is drawing showing the process after the middle stage at the time of manufacturing the liver model which is equivalent to the liver of drawing 1 by the 1st approach of this invention in the example 1.

[Drawing 5] It is drawing showing the liver model finally obtained with the process of the last at the time of manufacturing the liver model which is equivalent to the liver of drawing 1 by the 1st approach of this invention in the example 1.

[Drawing 6] It is drawing showing the slice configuration data (slice cross-section data) (with the support section) of each class obtained from the data of the liver of ********** and drawing 1 in the example 2.

[Drawing 7] It is drawing showing the process at the time of manufacturing the liver model which is equivalent to the liver of drawing 1 by the 2nd approach of this invention in the example 2.

[Drawing 8] It is drawing showing the outline of the liver model with a support which adopted the 2nd approach of this invention and was obtained in the example 2.

[Drawing 9] It is drawing showing the outline of a living body model of having the muscular equivalent part which adopted the 3rd approach of this invention and was obtained in the example 3, and a bone equivalent part.

[Drawing 10] It is drawing showing the slice configuration data (slice cross-section data) of each class for obtaining the living body model of drawing 9 used in the example 3.

[Drawing 11] It is drawing showing the solid molding object which was obtained in the example 3, and which was mostly surrounded with the photo-setting resin constituent which is not carrying out photo-curing.

[Description of Notations]

1 Nozzle

2 Nozzle

3 Molding Stage

5 Ink Jet Head for Optical Electric Shielding

7 Black Light

11 Nozzle

12 Nozzle

13 Nozzle

# This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

## BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☑ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

**IMAGES ARE BEST AVAILABLE COPY.**
**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**